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CONSERVATION AND PROTECTION
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DISTRIBUTION AND ENVIRONMENTAL IMPACT OF SELECTED BENTHIC CONTAMINANTS IN VANCOUVER HARBOUR, BRITISH COLUMBIA

1985 TO 1987

Regional Program Report: 89-02

by

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REVIEW NOTICE

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ABSTRACT

Environment Canada initiated a study of selected contaminants in Vancouver Harbour sediments and biota in May of 1985 following a review of existing environmental information on the harbour. The study objectives were to determine the distribution of specific organic and inorganic contaminants, potential industrial and urban sources, the health of the benthic environment, and the need for remedial measures. A total of 88 stations for sediment and 11 trawl stations for biota were sampled in Vancouver Harbour (Point Atkinson to Port Moody Arm) from May 1985 to October 1987. Sediment studies focused on the concentration and distribution of trace metals (e.g. arsenic, cadmium, chromium, copper, iron, mercury, nickel, lead and zinc), hydrocarbons, polychlorinated biphenyls (PCB), chlorophenols, and polycyclic aromatic hydrocarbons (PAH). The emphasis of the biological studies was trace metal and PAH levels in tissue of benthic (bottom dwelling) species including sole, crab and shrimp. Further study of the prevalence of liver lesions in English sole, associated with chemical exposure, was also undertaken. Potential urban and industrial sources of contamination in Vancouver Harbour have been identified.

key words: Vancouver Harbour, contaminants, sediment, biota, trace metals, polycyclic aromatic hydrocarbon, PAH, polychlorinated biphenyl, PCB, liver lesions, benthic.

RESUME

Environnement Canada a initié une étude de contaminants sélectionnés dans les sédiments et les organismes marins du Port de Vancouver en mai 1985 à la suite d'une revue de l'information environnementale existante dans les eaux du port. Les objectifs de l'étude étaient de déterminer la distribution de contaminants organiques et inorganiques spécifiques, les sources potentielles industrielles et urbaines, la santé de l'environnement benthique, et le besoin de mesures de redressement. Un total de 88 stations pour les sédiments et 11 stations de chalutage pour les organismes marins furent échantillonnées dans le Port de Vancouver (Point Atkinson à Port Moody Arm) de mai 1985 à octobre 1987. Les études de sédiment portaient plus particulièrement sur la concentration et distribution des métaux à l'état de trace (e.g. arsenic, cadmium, chrome, cuivre, fer, mercure, nickel, plomb et zinc), hydrocarbures, biphényles polychlorés (BPC), chlorophénols, et hydrocarbures aromatiques polycycliques (HAP). Les études biologiques ont mis l'accent sur les niveaux de métaux à l'état de trace et de HAP dans les tissus des espèces benthiques (habitant le fond) incluant les soles, crabes et crevettes. Une étude additionnelle de la prédominance de lésions dans le foie des soles anglaises, associée avec l'exposition de produits chimiques, fut aussi entreprise. Les sources potentielles de contamination d'origine urbaine et industrielle dans le Port de Vancouver furent aussi identifiées.

Mots-clés: Port de Vancouver, contaminants, sédiment, organismes marins, métaux à l'état de trace, hydrocarbure aromatique polycyclique, HAP, biphényle polychloré, BPC, lésions de foie, benthique.

TABLE OF CONTENTS

PAGE

REVIEW NOTICE i

ABSTRACT ii

RESUME iii

TABLE OF CONTENTS iv

  List of Tables vi

  List of Figures vii

  List of Appendices ix

EXECUTIVE SUMMARY x

1.0 **INTRODUCTION** 1

2.0 **DESCRIPTION OF STUDY AREAS** 4

  2.1 Vancouver Harbour 4

    2.1.1 Outer Harbour 4

    2.1.2 Inner Harbour 4

    2.1.3 Central Harbour 7

    2.1.4 Eastern Harbour - Port Moody Arm 7

  2.2 Loughborough Inlet (Reference Site) 8

3.0 **MATERIALS AND METHODS** 9

  3.1 Field Surveys 9

  3.2 Computer Graphics 12

4.0 **RESULTS AND DISCUSSION** 13

  4.1 Sediment Chemistry 13

    4.1.1 Surface Sediment Trace Metal Distribution 15

      4.1.1.1 Arsenic 17

      4.1.1.2 Cadmium 22

      4.1.1.3 Chromium 27

      4.1.1.4 Copper 30

      4.1.1.5 Mercury 34

      4.1.1.6 Lead 38

      4.1.1.7 Zinc 42

TABLE OF CONTENTS (Continued)

PAGE

4.1.2 Surface Sediment Trace Organic Compounds 46
4.1.2.1 Oils and Grease and Hydrocarbons 46
4.1.2.2 Polycyclic Aromatic Hydrocarbons 51
4.1.2.3 Polychlorinated Biphenyls 59
4.1.2.4 Chlorophenols 62
4.1.2.5 Organotins 65
4.1.3 Surface Sediment Characteristics 65
4.1.4 Bacteria Content 71
4.2 Biota 72
4.2.1 Species Abundance 72
4.2.2 Trace Metals in Tissue 73
4.2.3 PAH Concentrations in Tissue 74
4.2.4 Flatfish Tissue Abnormalities 78
4.2.4.1 External Abnormalities 78
4.2.4.2 Liver Lesions 78
4.2.5 Benthic Infauna 87
4.3 Sediment Toxicity 88
4.3.1 Amphipod Bioassays 88
4.3.2 Macoma Bioassays 89
4.4 Conclusions 89
5.0 REMEDIAL ACTIONS 90
REFERENCES 92
ACKNOWLEDGEMENTS 99

APPENDICES

LIST OF TABLES

TABLE		PAGE
1	Range in Mean Surface Sediment Concentration of Selected Concentrations in Vancouver Harbour (1985/86 & 1987) and Loughborough Inlet (1987)	14
2	Range in Mean Surface Sediment Trace Metal Concentrations by Area - Vancouver Harbour - 1985/86 & 1987	16
3	Concentration Percentile and Maximum Concentration Values (µg/g Dry Weight) for Sediment Trace Metals in Vancouver Harbour for the Total Study Area and Subareas - 1985/86 ..	18
4	Comparison of Vancouver Harbour Sediment Trace Metals to Puget Sound Using Concentration Percentiles, and Benthic AET (µg/g Dry Weight)	19
5	Comparison of PAH Toxicity Based on the Benthic Apparent Effects Threshold (BAET) (Tetra Tech, 1986) and Relative Carcinogenicity (National Academy of Science, 1972)	53
6	Mean Polycyclic Aromatic Hydrocarbon (PAH) Concentrations (µg/g Dry Weight) in Vancouver Harbour - Low Molecular (LPAH), High Molecular Weight (HPAH) and Total PAH - 1985/86 and 1987	54
7	Sediment Particle Size Distribution in Vancouver Harbour (1985 - 1986)	66
8	Sediment Bacteria Content at Selected Stations in Vancouver Harbour - June 1986 (MPN/100 g)	71
9	Summary Table Showing the Ranges in Mean Tissue Trace Metal Concentration (µg/g Dry Weight), Dungeness crab, Pandalid shrimp and English sole - Vancouver Harbour, 1985 - 1986	73
10	Range of PAH Concentrations (µg/g Dry Weight) in Dungeness Crab Tissue Sampled from Vancouver Harbour (1986 and 1988)	76
11	Three Groups of Idiopathic Liver Lesions (Megalocytic Hepatosis, Preneoplasms and Neoplasms) in English sole (Parophrys vetulus) from Vancouver Harbour - 1986 and 1987	81
12	Prevalence of Preneoplasms and Neoplasms in the Liver of English sole (Parophrys vetulus) from Vancouver Harbour - 1986 and 1987	83

LIST OF FIGURES

FIGURE **PAGE**

1 Vancouver Harbour Study Area and Reference Site Loughborough Inlet 5

2 Four Hydrographic Regions of Vancouver Harbour - Outer, Inner, Central, and Eastern Harbours 6

3 Sediment and Biota Sampling Stations in Vancouver Harbour - Outer and Inner Harbour 10

4 Sediment and Biota Sampling Stations in Vancouver Harbour - Central Harbour and Port Moody Arm 11

5 Percentage of Stations Above Natural and Benthic AET Values 20

6 Surface Sediment Cadmium Distribution in Vancouver Harbour (1985/86) a) Inner Harbour b) Port Moody Arm 23

7 Mean Surface Sediment Cadmium Concentrations in Vancouver Harbour (1985-86) 24

8 Surface Sediment Chromium Distribution in Vancouver Harbour (1985/86) a) Inner Harbour b) Port Moody Arm 28

9 Mean Surface Sediment Chromium Concentrations in Vancouver Harbour (1985-86) 29

10 Surface Sediment Copper Distribution in Vancouver Harbour (1985/86) a) Inner Harbour b) Port Moody Arm 31

11 Mean Surface Sediment Copper Concentrations in Vancouver Harbour (1985-86) 33

12 Surface Sediment Mercury Distribution in Vancouver Harbour (1985/86) a) Inner Harbour b) Port Moody Arm 36

13 Mean Surface Sediment Mercury Concentrations in Vancouver Harbour (1985-86) 37

14 Surface Sediment Lead Distribution in Vancouver Harbour (1985/86) a) Inner Harbour b) Port Moody Arm 39

15 Mean Surface Sediment Lead Concentrations in Vancouver Harbour (1985-86) 41

LIST OF FIGURES (Continued)

FIGURE		PAGE
16	Surface Sediment Zinc Distribution in Vancouver Harbour (1985/86) a) Inner Harbour b) Port Moody Arm	44
17	Mean Surface Sediment Zinc Concentrations in Vancouver Harbour (1985-86)	45
18	Surface Sediment Hydrocarbon Distribution in Vancouver Harbour (1985/86) a) Inner Harbour b) Port Moody Arm	48
19	Mean Surface Sediment Hydrocarbon Concentrations in Vancouver Harbour (1985-86)	49
20A	Comparison of 1985/86 Sediment PAH Concentrations (µg/g Dry Weight) in Vancouver Harbour - Low Molecular Weight, High Molecular Weight and Total	55
20B	Comparison of 1987 Sediment PAH Concentrations (µg/g Dry Weight) in Vancouver Harbour - Low Molecular Weight, High Molecular Weight and Total	56
21	Surface Sediment PCB Distribution in Vancouver Harbour (1985/86) a) Inner Harbour b) Port Moody Arm.............	60
22	Mean Surface Sediment Polychlorinated Biphenyl (PCB) Concentrations in Vancouver Harbour (1985-86)	61
23	Surface Sediment PCP Distribution in Vancouver Harbour (1985/86) a) Inner Harbour b) Port Moody Arm	64
24	Mean Surface Sediment Volatile Residue (SVR) in Vancouver Harbour (1985-86)	69
25	Percent Normal vs. Neoplastic and Preneoplastic Liver Lesions in English Sole (Parophrys vetulus) from Vancouver Harbour (1986 and 1987) and Loughborough Inlet (1987)	82
26	Comparison of Individual Neoplastic and Preneoplastic Liver Lesions Observed in English Sole (Parophrys vetulus) in Vancouver Harbour (1986 and 1987) and Loughborough Inlet (1987)	84

LIST OF APPENDICES

APPENDIX

A Thomas, M. and D. Goyette. 1989. Vancouver Harbour Benthic Environmental Quality Studies - May 1985 to September 1986. **Trace Metals in Sediment**. Environment Canada, Conservation and Protection.

B Thomas, M. and D. Goyette. 1989. Vancouver Harbour Benthic Environmental Quality Studies - May 1985 to January 1986. **Organic Compounds in Sediment**. Environment Canada, Conservation and Protection.

C Boyd, J., B. Raymond and D. Goyette. 1989. Vancouver Harbour Benthic Environmental Quality Studies. **Trace Metals and Organic Compounds in Sediments - October 1987**. Environment Canada, Conservation and Protection.

D Thomas, M. and D. Goyette. 1989. Vancouver Harbour Benthic Environmental Quality Studies - May 1985 to September 1986. **Sediment Particle Size Distribution, Residue and Bacteria Content**. Environment Canada, Conservation and Protection.

E Thomas, M. and D. Goyette. 1989. Vancouver Harbour Benthic Environmental Quality Studies - May 1985 to January 1986. **Trace Metals in Tissues**. Environment Canada, Conservation and Protection.

F Thomas, M. and D. Goyette. 1989. Vancouver Harbour Benthic Environmental Quality Studies - May 1985 to September 1986. **Polycyclic Aromatic Hydrocarbons in Sole and Crab Tissues**. Environment Canada, Conservation and Protection.

G Brand, D. and D. Goyette. 1989. **Further Studies of the Prevalence of Idiopathic Liver Lesions in English Sole, *Parophrys vetulus*,** from Vancouver Harbour, British Columbia, 1987. Environment Canada, Conservation and Protection.

EXECUTIVE SUMMARY

Following a review of existing information on environmental conditions in Vancouver Harbour, Environment Canada initiated a study of selected contaminants in harbour sediments and biota (1985-87). Objectives were to:

1) determine the environmental health of the benthic environment and the need for remedial measures; and

2) describe the distribution of specific contaminants to aid in identifying potential industrial and urban sources.

Sediment studies focused on the concentration and distribution of trace metals, hydrocarbons, polycyclic aromatic hydrocarbons (PAH), polychlorinated biphenyls (PCB) and chlorophenols. Biological studies emphasized abundance and diversity of benthic (bottom dwelling) organisms, trace metal and PAH levels in tissues of selected species, and prevalences of liver lesions in English sole associated with chemical exposure.

Vancouver Harbour was divided into four areas for study: the outer harbour from Point Atkinson to First Narrows; the inner harbour between First and Second Narrows; the central harbour from Second Narrows to the entrance of Port Moody Arm; and the eastern harbour, Port Moody Arm. In the surveys conducted between 1985 and 1986, 73 stations for sampling sediment and 11 trawl stations for biota were established throughout the harbour. In 1987, 15 sediment stations were added to Port Moody Arm. Loughborough Inlet, a relatively undisturbed coastal fjord, provided an estimate of natural conditions in addition to references selected within the harbour.

Trace metals studied were primarily arsenic, cadmium, chromium, copper, iron, mercury, nickel, lead and zinc. Concentrations of these metals at each station were compared to estimated natural or background reference levels and one of the sediment quality values established from studies in Puget Sound, Benthic Apparent Effects Threshholds (BAET). The latter is the

estimated concentration of a particular contaminant above which adverse biological effects are always expected (i.e. a reduction in the taxa of benthic infauna).

- Arsenic concentrations throughout most of the harbour were below detection (<8 µg/g) with the exception of slightly elevated levels off the concentrate loading docks at Vancouver Wharves.

- Cadmium was above reference level (0.3 µg/g) at most stations and more than half were above the BAET (5.8 µg/g). Possible sources of cadmium, included oil refineries, bulk loading terminals, stormwater discharges and combined sewer overflows.

- Chromium was occasionally above reference level (50 µg/g) but rarely above BAET (59 µg/g) except in Port Moody Arm where the latter was exceeded at most of the stations. The major source appeared to be the oil refinery at Ioco.

- Copper was above reference level (65 µg/g) throughout the study area, although it was primarily above the BAET (310 µg/g) in the inner harbour. Major sources were the metal concentrate bulk loading facilities at Vancouver Wharves, unidentified sources at other deepsea docks, stormwater discharges and combined sewer overflows.

- Mercury was often above reference level (0.2 µg/g), but only two stations were above the BAET (0.88 µg/g). These two stations were near combined sewer overflows. Other possible sources were ship repair and shipbuilding facilities.

- Lead levels were elevated in most areas of the harbour, but were above the BAET (300 µg/g) in only two areas, off Vancouver Wharves and the Clark Drive/Vernon Relief combined sewer overflows. Other sources of lead contamination were the Ioco oil refinery and unidentified sources along the south shore of the inner harbour.

Trace metal concentrations in the surface sediments at most locations in Vancouver Harbour were substantially above those reported for Roberts Bank, Sturgeon Bank and Iona Island areas in the Fraser River estuary. Values reported for these areas have been included for comparison.

A summary of the organic compounds measured in Vancouver Harbour sediment is as follows.

- Oils and grease and hydrocarbon concentrations in sediment were high mainly in Port Moody Arm and along the south shore of the inner harbour. Major sources were the oil refineries and combined sewer overflows.
- PAH were included in the analysis because of their acute toxicity, mutagenic and carcinogenic properties, and links to certain types of liver lesions in English sole. Highest levels of PAH were found in Port Moody Arm, followed by the inner harbour. Levels were lower in the outer harbour and not detectable at the reference site. Chief sources were the combined sewer overflows at Clark Drive, the Ioco oil refinery, and near the Petro-Canada loading docks and Reed Point Marina.
- PCB occurred in the sediment at relatively low levels throughout the harbour and elevated in specific areas of the inner harbour. Past studies have shown higher levels at specific nearshore locations of the inner harbour. PCB's are of global concern because of their long term persistence in some environments, very strong tendency to bioaccumulate in tissues and severe biological effects at high tissue concentrations.

Sediment characteristics including particle size and organic carbon content were among the variables measured. These can control the bioavailability of trace metals and to a lesser extent partitioning of organic contaminants. Sediment types in Vancouver Harbour included:

- well oxygenated, largely mineral substrates capable of supporting marine life, occurring in most of the harbour;
- highly organic, reducing sediments with strong odours of highly toxic hydrogen sulfide gas, occurring mainly in Port Moody Arm; and
- sewage sludge deposits near the combined sewer overflows.

Vancouver Harbour continues to support a diverse benthic fish and invertebrate community, despite the extent of contamination noted above. In addition, there was no significant uptake of trace metals in tissues of selected benthic species sampled from offshore areas. Commercial and recreational species in the harbour have included Dungeness crab, pandalid shrimp, and sixteen species of flounder and sole. Presence of the smaller size classes of fish suggest the use of the harbour for rearing. Highest catches of shrimp occurred along the West Vancouver shore and entrance to Coal Harbour. Dungeness crab catches were generally higher in the inner harbour and Port Moody Arm. The latter area has supported a small commercial fishery. The inner harbour, between first and second narrows, is closed to fishing.

Generally, benthic infauna were diverse and abundant, indicating ecologically "healthier" biological communities than would be expected based on the level of contamination. Analysis showed distinctly different communities within the harbour. These differences may reflect variation in sediment types, levels of contamination, and natural variables such as water depth and circulation.

PAH was not detected in fish, although traces of PAH were found in some crab hepatopancreas (digestive gland) and muscle tissues. Because fish are known to metabolize PAH, the absence of detectable levels in tissues is expected even with considerable exposure. Measureable levels in crab tissues were found in Ioco and Coal Harbour.

In 1986, prevalence of idiopathic (non-infectious, non-parasitic) lesions in livers of English sole were dependent on area of capture.

Highest prevalences were found in Port Moody Arm (58% of the fish examined), followed by the north shore of the inner harbour near Burrard Yarrows (30%). In the outer harbour, 13% of sole livers had lesions while the south shore of the inner harbour was 10%. The lowest prevalence (8%) occurred in the centre of the inner harbour. The study was repeated in 1987 with similar results except that the maximum proportion of fish with lesions was 75%, again in Port Moody Arm. Both preneoplastic (precursors to tumor development) and neoplastic lesions (tumors) were included. The neoplastic lesions included both adenomas (non-invasive, or benign tumors) and carcinomas (cancer). Based on critera established in Puget Sound, all stations sampled in Vancouver Harbour in 1986 and 1987 would be classed as either primary or secondary areas of concern. Based on results from Vancouver Harbour, it is suggested that exposure to high molecular weight PAH concentrations as low as 3 - 4 µg/g in sediment could cause liver lesions in English sole.

Port Moody Arm is the area of the harbour most affected by accumulation of organic and inorganic contaminants followed by the inner harbour, along the south shore near the deepsea docks and north shore adjacent to bulk loading facilities.

A number of remedial actions have been initiated at industrial operations including the Ioco oil refinery, Pacific Coast Terminals and Vancouver Wharves, in cooperation with municipal and provincial authorities. A remedial action plan is currently in preparation by the Greater Vancouver Regional District, with the cooperation and support of various levels of government.

1.0 INTRODUCTION

Vancouver Harbour is the major seaport on the west coast of British Columbia serving a large industrial and urban community. Historically, the harbour has been subject to waste discharges from point and non-point sources. While considerable effort has been directed towards control and treatment of waste discharges, a number of stormwater outlets, municipal combined sewer overflows (CSO), industrial process effluents and urban runoff remain as potential sources of environmental impact on the harbour.

In addition to various recreational activities, the Harbour supports commercial, sport and native food fisheries on resident and migratory marine species including shrimp, crab, flatfish and salmon. Continual population growth and urban development in the Greater Vancouver area will increase the commercial and recreational value of Vancouver Harbour. Resulting pressure on the marine environment therefore demands a higher level of protection to maintain or improve environmental quality.

Studies of major urban centers in North America have investigated the environmental impacts associated with a variety of anthropogenic chemicals (Malins et al., 1980, 1982; O'Connor and Hugget, 1987; McCain et al., 1988; Wright and Phillips, 1988). Malins et al. (1984) reported more that 900 organic compounds in bottom sediments from Commencement Bay, an urbanized area in Puget Sound. Mean concentrations of aromatic hydrocarbons in some urban embayments exceeded those of undisturbed bays as much as 46 times. Recent studies in Puget Sound have shown elevated levels of aromatic hydrocarbons in the bile of fish resulting from exposure to contaminated sediments (Kraun, 1986). Aromatic hydrocarbons in sediments have also been linked to the development of idiopathic liver lesions in English sole (Malins et al., 1984, 1985, 1988; Myers et al., 1987; McCain et al., 1988). Over 300 aromatic hydrocarbons have been identified in sediment from Chesapeake Bay on the east coast of the United States (O'Connor and Huggett, 1988). Toxic effects from the contaminants and health risks associated with the consumption of contaminated seafood have prompted authorities in some areas, such as Puget Sound (PSWQA, 1988), to develop active remedial programs to cleanup and control sources of pollutants.

A review of existing environmental data on Vancouver Harbour identified toxicological effects of various inorganic and organic chemicals (Waters, 1985a, 1985b). Concentrating on the benthic environment, the report concluded that contamination ranged from chronic to severe. The Greater Vancouver Regional District (GVRD) has developed a Liquid Waste Management Plan (LWMP) to sewage and drainage disposal within the Greater Vancouver area. The Plan's purpose is to find the most environmentally acceptable and cost effective method of disposing of liquid wastes such as sewage treatment plant effluents, urban runoff and combined sewer overflows (GVRD, 1989). Part of this study included an inventory of existing data on receiving waters and a preliminary assessment of environmental conditions in the 21 major waterbodies including Vancouver Harbour (Coastline Environmental Services and Envirochem Limited 1987). The report concluded that data was limited. However, it did suggest that receiving water conditions were fair to poor for many waterbodies.

Following the reports by Waters (1985a, 1985b), Environment Canada, initiated a series of field studies in May of 1985 to investigate the distribution of organic and inorganic chemicals in the harbour. Since sediments generally provide a "sink" for contaminants, the study concentrated on levels in the sediments and associated biota. The primary objectives of the study were to:

1) establish a database of contaminant levels in sediment and biota to determine the status of the benthic environment in the harbour and the need for remedial measures.
2) provide data on the temporal and spatial distributions of specific contaminants to identify sources of input within the harbour.

Sediment chemical studies focused on the concentration and distribution of trace metals, hydrocarbons, oil and grease, polycyclic aromatic hydrocarbons (PAH), polychlorinated biphenyls (PCB) and chlorophenols. Biological studies emphasized tissue trace metal levels in selected benthic organisms (e.g. flatfish, crab and shrimp), tissue PAH concentrations in crab and sole, and prevalences of liver lesions in English sole (*Parophrys vetulus*) which are known to be associated with chemical exposure. Abundance and distribution of various epibenthic species in the harbour were also determined.

This report summarizes the results from 8 field surveys conducted between May 1985 and October 1987. Individual data reports provided in the Appendices, include:

Appendix A	Trace Metals in Sediment (1985/86)
Appendix B	Organic Compounds in Sediment (1985/86)
Appendix C	Trace Metals and Organic Compounds in Sediment (1987)
Appendix D	Sediment Particle Size Distribution, Residue and Bacteria Content (1985/86)
Appendix E	Trace Metals in Tissue (1985/86)
Appendix F	Polycyclic Aromatic Hydrocarbons in Sole and Crab Tissues (1985/86)
Appendix G	Further Studies on the Prevalence of Idiopathic Liver Lesions in English Sole.

2.0 DESCRIPTION OF STUDY AREAS

Geographical locations of the two study areas, Vancouver Harbour and the reference site, Loughborough Inlet, are shown in Figure 1.

2.1 Vancouver Harbour

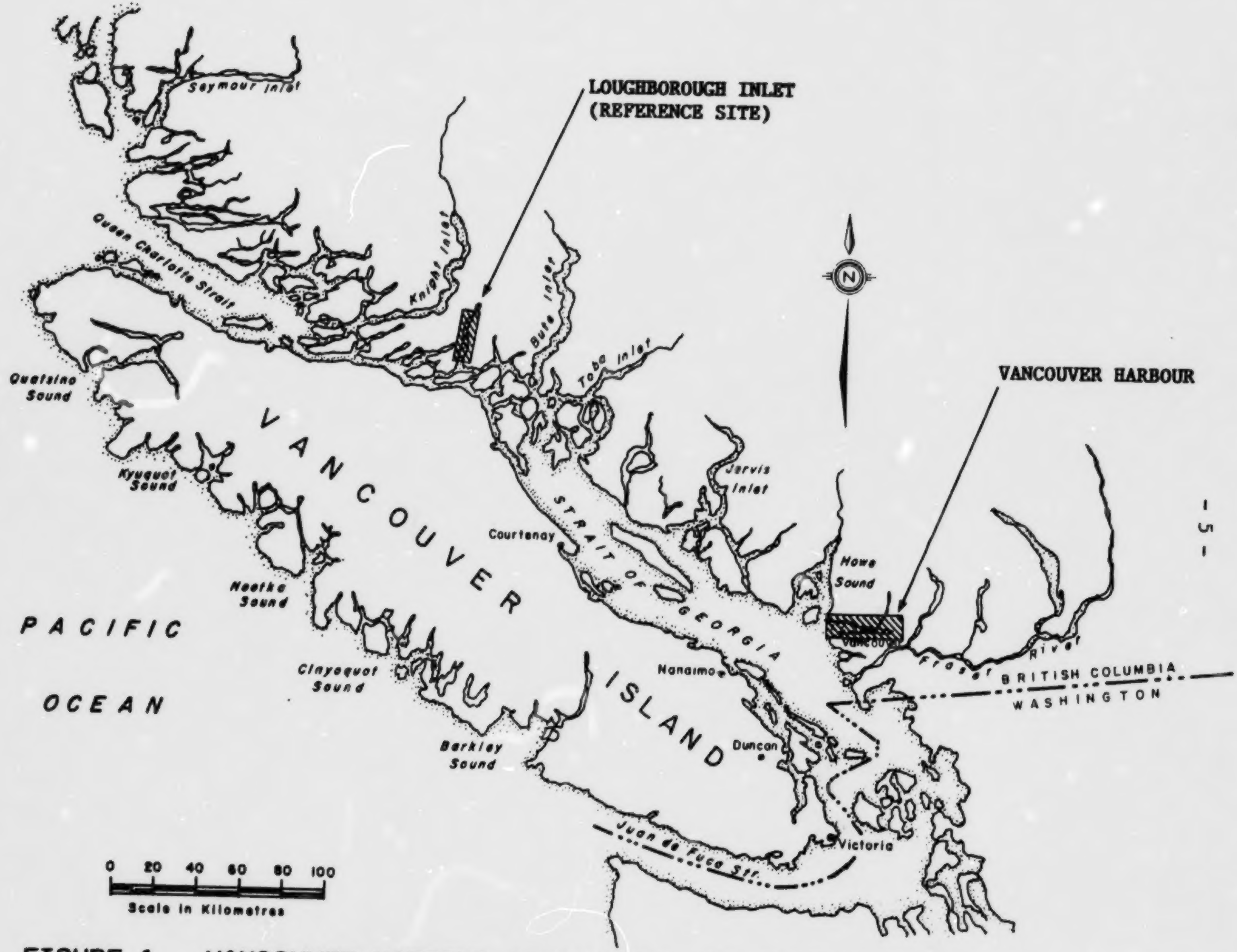
Vancouver Harbour was divided into four hydrographic regions (Figure 2): the outer harbour, which lies between Point Atkinson and First Narrows; the inner harbour, First to Second Narrows; the central harbour, which extends from Second Narrows to the entrance of Port Moody Arm; and eastern harbour, Port Moody Arm.

2.1.1 Outer Harbour

The outer harbour is approximately 70 km^2 and predominantly bounded by residential areas and parkland. The Lions Gate primary sewage treatment plant, near the entrance to First Narrows, is the major point source discharge into the outer harbour. Effluent is discharged through a submerged outfall and digested sludge is periodically released with the effluent during ebb tides. The outer harbour is influenced by the Fraser River and tidal outflows from the inner harbour, False Creek and Howe Sound. While it is a popular area for recreational boating, fishing and swimming, it also provides anchorage for deep sea vessels awaiting berthage in the inner harbour. A small commercial shrimp and crab fishery operates along the Spanish Banks and West Vancouver shoreline.

2.1.2 Inner Harbour

The inner harbour is the most active region of the harbour with a variety of urban, industrial and other harbour activities along the south and north shores. The distance between First and Second Narrows is about 8.5 km; maximum width of the inner harbour is about 3.7 km. Average depths range from 21 to 65 metres. Tides in the inner harbour are from -0.2 to 5.6 metres with an average of 3.3 metres (Canadian Hydrographic Service Annual



LOUGHBOROUGH INLET
(REFERENCE SITE)
VANCOUVER HARBOUR
Seymour Inlet
Queen Charlotte Strait
Knight Inlet
Bute Inlet
Toba Inlet
Jervis Inlet
Howe Sound
Vancouver
Fraser River
BRITISH COLUMBIA
WASHINGTON
Quatsino Sound
Kyuquot Sound
Nootka Sound
Clayoquot Sound
Barkley Sound
PACIFIC
OCEAN
VANCOUVER
ISLAND
STRAIT OF GEORGIA
Courtenay
Nanaimo
Duncan
Victoria
Juan de Fuca Str.
N
0
20
40
60
80
100
Scale in Kilometres

FIGURE 1 VANCOUVER HARBOUR STUDY AREA AND REFERENCE SITE, LOUGHBOROUGH INLET

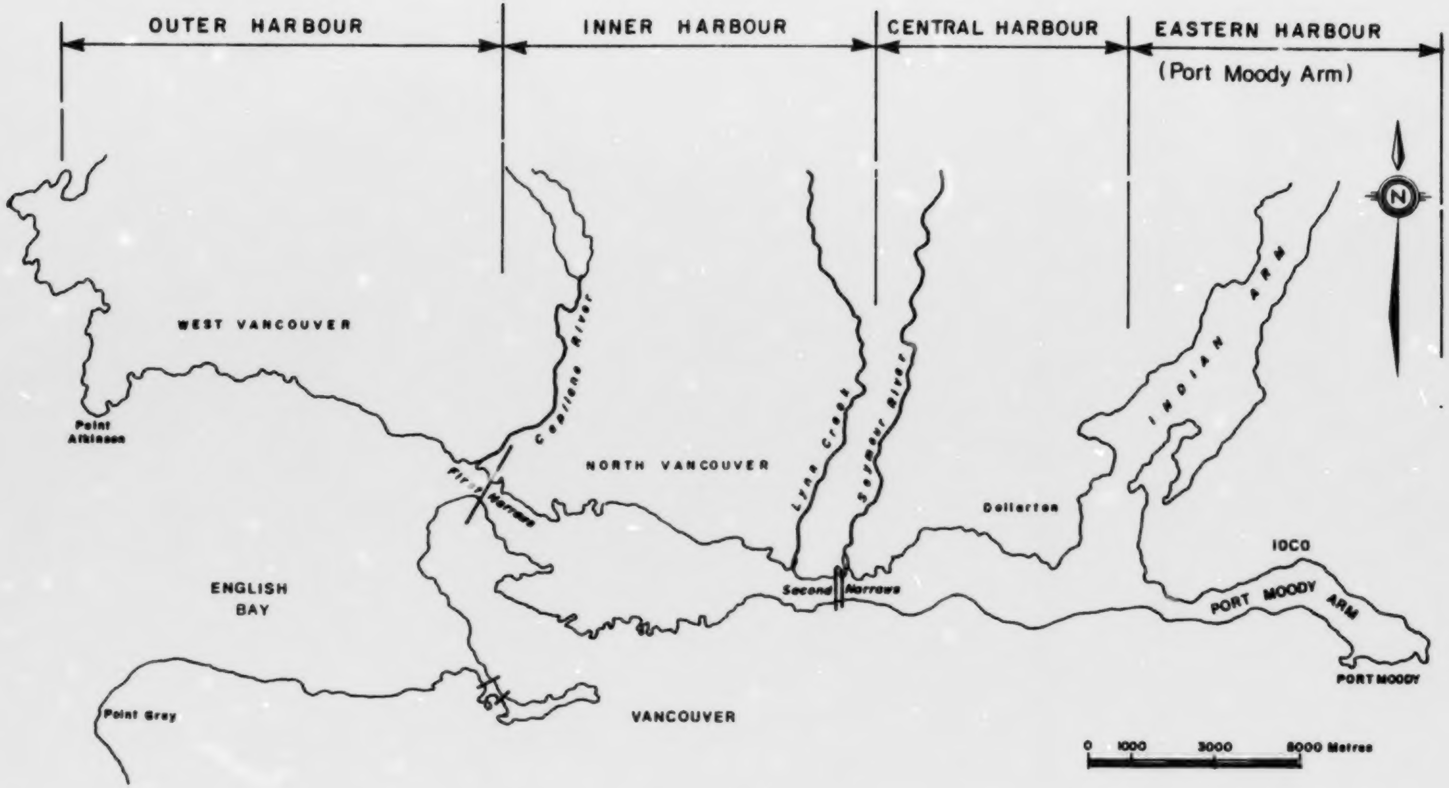

OUTER HARBOUR
INNER HARBOUR
CENTRAL HARBOUR
EASTERN HARBOUR
(Port Moody Arm)
N
WEST VANCOUVER
Point Atkinson
Capilano River
First Narrows
NORTH VANCOUVER
Lynn Creek
Seymour River
Second Narrows
Dollarton
INDIAN ARM
IOCO
PORT MOODY ARM
PORT MOODY
ENGLISH BAY
Point Grey
VANCOUVER
0 1000 3000 5000 Metres

FIGURE 2 FOUR HYDROGRAPHIC REGIONS OF VANCOUVER HARBOUR - OUTER, INNER, CENTRAL, AND EASTERN HARBOURS

Tide and Current Tables, 1989) and currents through the First and Second narrows can exceed 6 knots. The inner harbour and portions of the outer and central harbours receive a considerable degree of flushing and mixing (Canadian Hydrographic Service Tidal Current Atlas, 1981), which can influence the distribution and deposition of contaminants within the harbour.

Industrial activity in the inner harbour includes among others bulk loading facilities (coal, sulphur, potash, phosphate, metal concentrates, wood chips, and grain), marinas, shipyards, sawmills, fish processing plants and fuel docks. Generally, municipal sewage is treated by either the Lions Gate sewage treatment plant or treatment plants located along the Fraser River. However, during periods of heavy rainfall municipal sewage and stormwater can discharge directly to the harbour through combined sewer overflows located along the north and south shores of the harbour.

2.1.3 Central Harbour

The central harbour covers an area of approximately 10 km^2; the width averages 1.4 km. Tidal currents through Second Narrows can extend throughout this section. The central harbour is comprised of a mixture of industrial and residential areas. Industrial activities include a sodium chlorate plant and a chlor-alkali plant, two petrochemical refineries, a crude oil terminal, shipyards, a sawmill and additional anchorage for deepsea vessels. Treated process effluent from both refineries is discharged directly into the GVRD sewer system. Treated stormwater from tank farms and refinery areas is discharged directly to the harbour.

2.1.4 Eastern Harbour - Port Moody Arm

Port Moody Arm, about 7.0 km in length, is relatively shallow, (mean depth of 9 metres) and requires periodic dredging to maintain shipping channels. The head of the arm is mainly tidal flats. No major river systems flow into Port Moody Arm and water circulation is relatively poor, Waldichuk (1965) estimated a 30% exchange of water during each tidal cycle.

Industrial activity in Port Moody Arm includes two petroleum refineries, which discharge treated stormwater directly into the arm, a thermal power generating plant (using natural gas since 1978), a bulk loading terminal, two chemical plants (phenolic resin, alum), a sawmill and a marina. The release of treated process effluent by one of the refineries ceased in March of 1989. Municipal sources in Port Moody Arm include two combined sewer overflows, a number of stormwater discharges and an abandoned landfill site. Portions of the shoreline are also used for residential areas and marine parklands.

2.2 Loughborough Inlet (Reference Site)

Loughborough Inlet is a relatively undisturbed coastal inlet located between Knight and Bute inlets approximately 40 miles north of Campbell River (Figure 1). Minor activities in the area are logging and recreational boating.

3.0 MATERIALS AND METHODS

3.1 Field Surveys

The sampling locations in Vancouver Harbour are shown in Figures 3 and 4, and outlined below. Sites were named for ease of reference and do not necessarily imply a source of contamination.

		Sediment	Biota
Outer Harbour	- Spanish Banks	SB	-
	- Point Atkinson	ATK	-
	- Pacific Environment Institute	PEI	Pacific Environment Institute
	- Dundarave	DD	-
Inner Harbour	- North Shore	1 - 13B	Burrard Yarrows
	- Centre	14 - 16	Centre
	- South Shore	17 - 31	Sterling, Coal Harbour Vanterm
Central Harbour	- Chevron	-	Chevron
	- Cates Park	CP	-
	- Boulder Rock	BR	-
Eastern Harbour	- Port Moody Arm	32 - 47	Ioco, Port Moody

Six surveys were conducted between 1985 and 1986 to sample 73 stations for sediment and 11 trawl stations for biota. Due to the extent of the study area, most sediment sampling sites with the exception of certain trawl stations were sampled only once to maximize coverage. In October 1987, sediment sampling was concentrated in Port Moody Arm including 17 existing stations and 15 new stations. In 1987, two stations in Loughborough Inlet, were added to provide a baseline reference for sediment and English sole liver lesions.

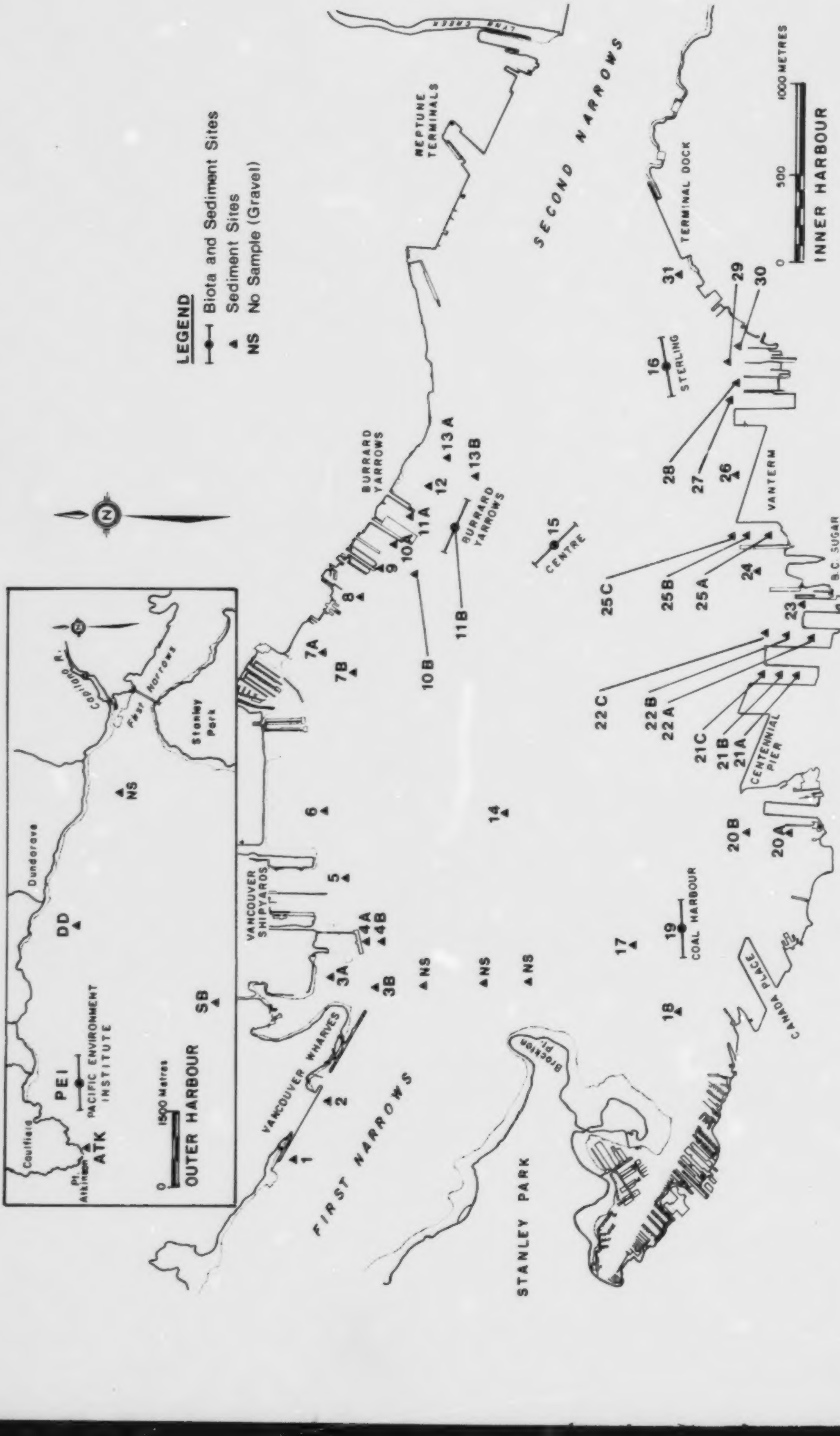

LEGEND
Biota and Sediment Sites
Sediment Sites
NS No Sample (Gravel)
OUTER HARBOUR
0
1500 Metres
Pt. Atkinson
ATK
Caulfeild
PEI
PACIFIC ENVIRONMENT INSTITUTE
SB
DD
Dundarave
NS
Capilano R.
First Narrows
Stanley Park
INNER HARBOUR
0
500
1000 METRES
FIRST NARROWS
STANLEY PARK
SECOND NARROWS
VANCOUVER WHARVES
VANCOUVER SHIPYARDS
BURRARD YARROWS
NEPTUNE TERMINALS
LYNN CREEK
TERMINAL DOCK
STERLING
VANTERM
B.C. SUGAR REFINERY
CENTENNIAL PIER
CANADA PLACE
COAL HARBOUR
CENTRE
Brockton Pt.
1
2
3A
3B
4A
4B
5
6
7A
7B
8
9
10A
10B
11A
11B
12
13A
13B
14
15
16
17
18
19
20A
20B
21A
21B
21C
22A
22B
22C
23
24
25A
25B
25C
26
27
28
29
30
31
NS
NS
NS

FIGURE 3 SEDIMENT AND BIOTA SAMPLING STATIONS IN VANCOUVER HARBOUR - OUTER AND INNER HARBOUR

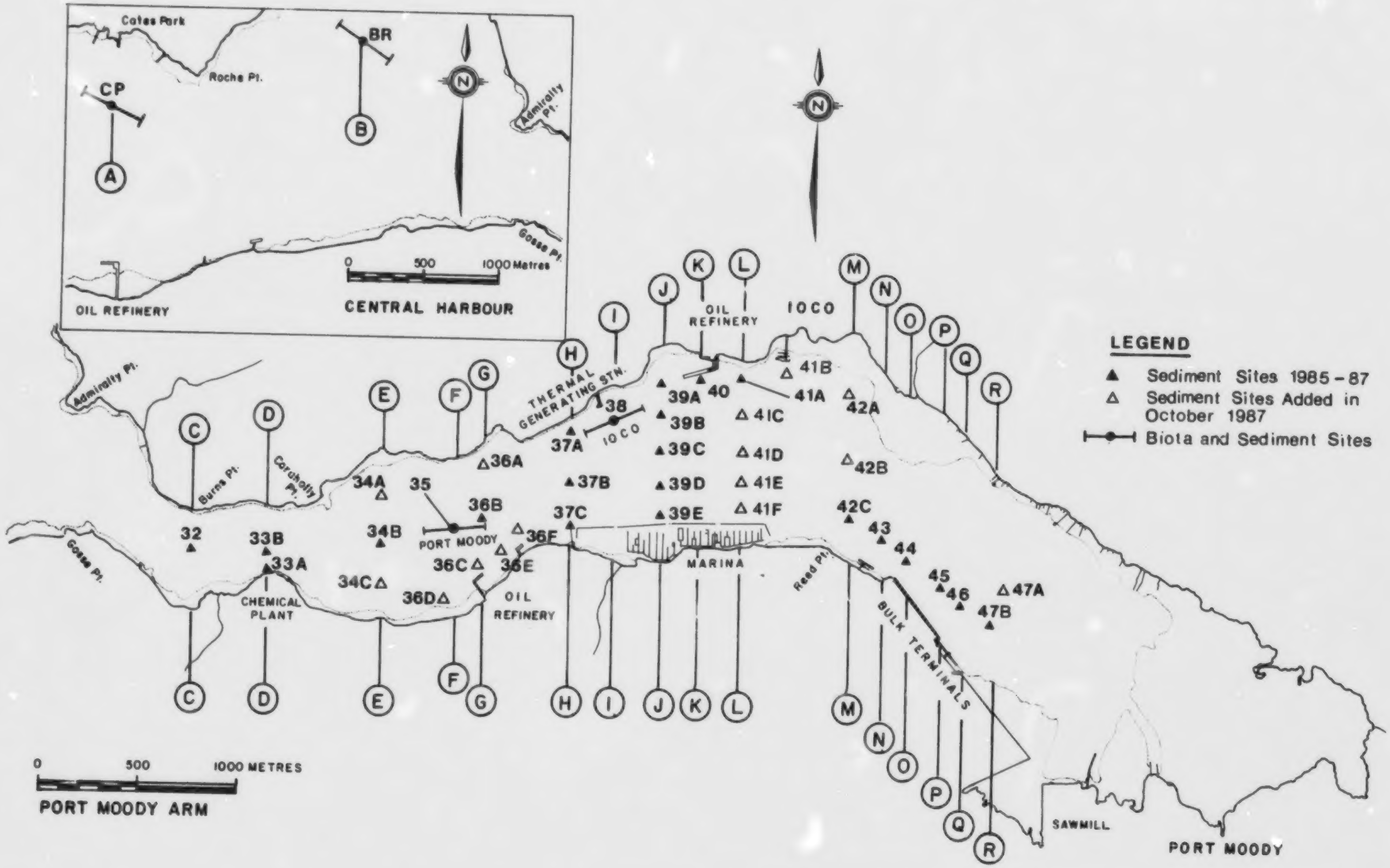

Cates Park
Roche Pt.
CP
A
BR
B
N
Admiralty Pt.
Gosse Pt.
OIL REFINERY
0
500
1000 Metres
CENTRAL HARBOUR
Admiralty Pt.
Gosse Pt.
Burns Pt.
Carraholly Pt.
C
D
E
F
G
H
I
J
K
L
M
N
O
P
Q
R
THERMAL GENERATING STN.
IOCO
OIL REFINERY
IOCO
N
32
33A
33B
34A
34B
34C
35
36A
36B
36C
36D
36E
36F
37A
37B
37C
38
39A
39B
39C
39D
39E
40
41A
41B
41C
41D
41E
41F
42A
42B
42C
43
44
45
46
47A
47B
PORT MOODY
CHEMICAL PLANT
OIL REFINERY
MARINA
Reed Pt.
BULK TERMINALS
SAWMILL
PORT MOODY
LEGEND
▲ Sediment Sites 1985 - 87
△ Sediment Sites Added in October 1987
Biota and Sediment Sites
0
500
1000 METRES
PORT MOODY ARM

FIGURE 4 SEDIMENT AND BIOTA SAMPLING STATIONS IN VANCOUVER HARBOUR - CENTRAL HARBOUR AND PORT MOODY ARM

Details on sampling schedule, collection methods, and laboratory analyses are given in Appendices A-G.

Earlier reports on the prevalence of external abnormalities in flatfish and liver lesions in English sole (Goyette et al., 1987) and species abundance and distribution (Goyette and Thomas, 1987) in Vancouver Harbour may also be referred to for specific methods.

3.2 Computer Graphics

Bar graphs were generated by customized software to illustrate surface sediment concentrations in Vancouver Harbour relative to baseline levels, CEPA ocean dumping criteria (formally the Ocean Dumping Control Act - O.D.C.A.), and the benthic Apparent Effects Thresholds (BAET). The latter criteria, developed in Puget Sound, define the sediment concentration level at which a detrimental effect is expected 100% of the time. Spatial distribution maps for the inner harbour and Port Moody Arm in 1985/86 were prepared using a microcomputer based geographic information system (GIS), and spatial analysis system (SPANS). Contaminant concentrations were interpolated between sampling points using 0.75 km radius of influence. An exponential function was used to model the influence of each data point with distance (i.e. the influence would drop by half from the sample point). Concentration ranges were pre-selected to reflect the overall concentration range throughout the harbour, natural reference levels, and federal CEPA ocean dumping criteria. A maximum of 5 concentration ranges were choosen for ease of reference.

4.0 RESULTS AND DISCUSSION

The following discussion is based on results provided in the individual data reports (Appendicies A to G). Refer to the relevant report for specific information, such as raw data and descriptive statistics (mean, standard deviation, and ranges). All chemical results are given in µg/g, dry weight.

4.1 Sediment Chemistry

Most chemical pollutants have a strong affinity for particulate matter, ultimately accumulating in the bottom sediments. Murphy et al. (1988), for example, reported that over 90% of the hydrocarbons entering Puget Sound are deposited in the estuarine sediments; 63% percent of the PAH and 100% of the petroleum hydrocarbons settled directly from surface waters. Based on accumulation and geographical distribution, sediment chemistry can indicate potential point and non-point sources of pollutants as well as the temporal and spatial extent of the impact. In addition, it can provide a relative measure of the overall benthic environmental quality and potential toxicological conditions. Concentration alone, however, does not necessarily dictate the degree of environmental impact. The availability of chemical contaminants to the environment in general, will also depend on other factors, such as pH, redox potential, oxygen content, and organic content of the sediment or overlying water (Dickson et al., 1987).

Concentration can also depend on sediment particle size. Generally, the finer the fraction, the higher the concentration due to increased surface area and therefore chemical affinity. Sediments in this study were clay/silt to fine sand (<149 microns or minus 100 mesh). Table 1 summarizes the range in mean surficial sediment concentration of the chemical contaminants measured in Vancouver Harbour (1985/86 and 1987) and Loughborough Inlet (1987).

Puget Sound has been the subject of numerous studies on organic and inorganic contaminant levels and associated biological effects (Tetra Tech,

TABLE 1 RANGE IN MEAN SURFACE SEDIMENT CONCENTRATION OF SELECTED CONTAMINANTS IN VANCOUVER HARBOUR (1985/86 & 1987) AND LOUGHBOROUGH INLET (1987)

Parameter	Concentration in µg/g, dry weight Vancouver Harbour	Loughborough Inlet (reference site)
Trace Metals		
Arsenic	<8 - 96	<8
Cadmium	<.3 - 10.2	0.31 - 0.65
Chromium	29 - 267	32.2 - 38.8
Copper	48 - 9760	56 - 72
Iron	2.2 - 8.2	2.9 - 3.6
Mercury	0.11 - 4.6	0.12 - 0.13
Nickel	7 - 119	18 - 25
Lead	17 - 15,420	21 - 23
Zinc	88 - 2267	102 - 135
Organic Compounds		
Hydrocarbons	19 - 6587	57 - 70
PAH - Total	1.34 - 36.89	-
- LPAH	0.31 - 7.51	-
- HPAH	1.02 - 32.14	-
PCB	<0.02 - 0.90	0.02 - 0.05
Chlorophenols		
Penta-	<0.0001 - 0.135	<0.0001
Tetra-	<0.0002 - 0.079	-
Tri-	<0.0005 - 0.0245	-

1986; Evans-Hamilton and D.R. Systems, 1987; Malins et al., 1985, 1988; Puget Sound Water Quality Authority, 1988). In addition, sediment quality values (SQV) for a variety of inorganic and organic chemicals have been developed for Puget Sound (Tetra Tech, 1986). The Apparent Effects Threshold (AET) is an SQV which represents the sediment concentration of a particular contaminant above which biological effects would always be expected within 95% confidence. These criteria have been empirically derived from paired sediment chemistry data for a range of biological effects indicators (e.g. amphipod mortality, oyster larvae abnormalities, Microtox bioassays, and reduction in total benthic infauna abundance). The SQV's were intended for preliminary screening for ocean disposal of sediment and while certain geochemical differences may exist between the two areas, they can provide a relative measure of the toxicological state of the Vancouver Harbour sediments. Comparisons have therefore been made between the 1985/86 results from Vancouver Harbour and the Puget Sound AET values for benthic infauna (BAET). These latter values have been based on a 50% reduction in total abundance of major taxa.

4.1.1 Surface Sediment Trace Metal Distribution

Ranges in mean surface sediment trace metal concentration for arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), iron (Fe), mercury (Hg), nickel (Ni), lead (Pb) and zinc (Zn) specific of Vancouver Harbour in 1985/86 are given in Table 2. Estimated natural concentrations using Spanish Banks and Cates Park sampling stations in Vancouver Harbour, Loughborough Inlet sampled in 1987, and Puget Sound reference levels (Tetra Tech, 1986; Evans-Hamilton and D.R. Systems, 1987) are also included for comparison. The results from Spanish Banks (SB) and Cates Park (CP) sampling stations indicated that sediments were relatively free from anthropogenic trace metals. Concentrations at both sites were also within the limits found at other non-urban, non-industrialized areas along the B.C. coast (Goyette and Christie, 1982; Harding and Thomas, 1987), including Loughborough Inlet.

TABLE 2 RANGE IN MEAN SURFACE SEDIMENT TRACE METAL CONCENTRATIONS BY AREA - VANCOUVER HARBOUR - 1985/1986 & 1987

AREA	CONCENTRATION (µg/g, dry weight)									
	As	Cd	Cr	Cu	Fe(%)	Hg	Ni	Pb	Zn	No. of Stations
OUTER HARBOUR - 1985/86	<3-28	<0.3-0.8	55-67	65-504	3.8-4.1	0.14-0.29	7-51	17-67	108-206	4
- 1987	<3	.24 -.38	49-52	180-298	3.7-3.8	0.15-0.17	37-40	40-53	142-157	2
INNER HARBOUR - 1985/86	<3-96	<0.3-7.4	29-77	90-4353	2.2-8.2	0.09-4.6	9-296	20-15400	93-2267	44
-North Shore	<3-96	<0.3-7.4	29-77	115-4353	2.5-8.2	0.09-3.1	9-296	20-15400	93-2267	19
-Centre	<3-19	0.56-0.76	33-43	333-465	2.7-3.4	0.21-0.33	22-32	64-85	155-235	2
-South Shore	<3-27	<0.3-1.6	32-52	90-991	2.2-3.6	0.13-4.6	15-65	59-343	113-374	23
Central Harbour - 1985/86	<3	<0.3 0.5	28-30	64-152	2.8-3.6	0.11-0.27	7-18	19-48	88-131	2
Eastern Harbour - 1985/86	<3-40	<0.3-2.4	48-267	48-184	3.3-4.7	0.13-0.49	22-44	12-182	98-461	23
- 1987	-	.8-10.2	48-128	62-238	3.2-4.4	0.11-0.47	25-32	19-298	192-317	32
Spanish Banks* Cates Park* - 1985/86	<3	<0.3	29-50	64-65	3.6-3.9	0.11-0.14	7-39	17-19	19-108	2
Loughborough Inlet** - 1987	<3	0.31-0.56	33.8-38.4	62-65	3.0-3.4	0.12	21-23	22	103-137	2
Puget Sound***	17	1.9	59	74	-	0.28	-	24	100	-

* Vancouver Harbour Reference Sites

** Coastal Reference Sites

*** Puget Sound Reference Levels (Source: Evans-Hamilton and D.R. System, 1987; Tetra Tech, 1986 for mercury)

Concentration percentiles (50, 75, 90) by area for Vancouver harbour are given in Table 3, including the level and station location of maximum concentrations. Table 4 compares the concentration percentiles for Vancouver Harbour with those reported for Puget Sound (Tetra Tech, 1986). Maximum concentrations for chromium, iron, nickel, and lead in Vancouver Harbour exceeded those reported for Puget Sound. Ninety percentile values for chromium, copper, iron and zinc were also higher. These also exceeded the BAET. Concentrations of other trace metals have been summarized in Appendix A and C.

Sediment samples were routinely collected at each trawl station (PEI, 11B, 15, 16, 19, 35, and 38) to provide comparable data for tissue trace metals and to assess seasonal variability. PEI, for example, was sampled on 5 occasions between 1985 and 1987 (Appendix A & C). Based on an analysis of variance (ANOVA), there were no obvious seasonal differences.

Compared to the estimated natural reference levels for Vancouver Harbour, all stations except Spanish Banks and Cates Park showed elevated sediment concentrations of at least one trace metal. Some concentrations were substantially above the reference values. Copper and lead concentrations at Station 1, near the metal concentrate loading dock at Vancouver Wharves, were up to 150 and 642 times the reference level. Figure 5 illustrates the percentage of sampling stations above the natural reference concentration and the Puget Sound BAET value for cadmium, chromium, copper, mercury, lead, and zinc.

The following discusses the distribution pattern of more important trace metals in the harbour and compares them to the Puget Sound BAET, Fraser River estuary and Ocean Dumping Criteria established under CEPA.

4.1.1.1 Arsenic. Arsenic compounds can be released into the environment through pesticide use, refining and smelting of nonferrous metals, fossil fuel combustion, incineration of municipal waste, use of arsenic based wood preservatives, and burning of wood treated with arsenic based preservatives (Garrett, 1988). In a review of information on arsenic in the environment,

TABLE 3 CONCENTRATION PERCENTILE AND MAXIMUM CONCENTRATION VALUES (µg/g DRY WEIGHT) FOR SEDIMENT TRACE METALS IN VANCOUVER HARBOUR FOR THE TOTAL STUDY AREA AND SUBAREAS - 1985/86

	TOTAL AREA			OUTER HARBOUR			INNER HARBOUR (North Shore)			INNER HARBOUR (South Shore)			PORT MOODY ARM			Maximum Concen-tration	Station
	50	75	90	50	75	90	50	75	90	50	75	90	50	75	90		
Cd	.63	.99	1.80	.28	.60	.72	.60	2.40	6.30	.85	1.20	1.60	.60	1	1.60	7.70	3A
Cr	42.5	59.4	81.9	55.2	58.3	64.7	42	49	61	13	34	39	67	91	141	310	41
Cu	236	361	685	208	220	449	285	685	2140	341	426	762	161	181	193	8890	1
Fe	33500	38000	42800	39800	41700	45200	32500	36700	53700	30600	32100	34100	37500	39500	46500	102000	1
Hg	.21	.29	.46	.24	.26	.29	.16	.22	.31	.29	.43	.62	.40	.41	.47	9.63	25A
Ni	27	32	43	42	43	49	20	33	45	27	31	35	27	31	33	404	1
Pb	59	85	179	47	64	69	81	159	315	80	110	143	110	131	138	30000	1
Zn	149	214	489	148	160	195	380	708	1480	213	256	303	214	243	359	3050	1

TABLE 4 COMPARISON OF VANCOUVER HARBOUR SURFACE SEDIMENT TRACE METALS TO PUGET SOUND* USING CONCENTRATION PERCENTILES, AND BENTHIC AET (μg/g, dry weight)

	VANCOUVER HARBOUR					BENTHIC AET	PUGET SOUND*			
	50	75	90	MAX.	MIN.		50	75	90	Max.
Cd	0.63	0.99	1.80	7.7	<.3	5.8	.48	1.78	3.07	180
Cr	42.5	59.4	81.9	310	21	59	35	53	66	129
Cu	236	361	685	8890	48	310	49	83	167	11400
Fe	3.35	3.80	4.28	10.2	2.2	3.7	1.9	2.7	3.2	5.3
Hg	.21	.29	.46	9.63	.09	.88	.20	.46	.98	52
Ni	27	32	43	296	7	49	27	41	50	118
Pb	59	85	179	30000	12	300	39	92	190	6250
Zn	149	214	489	3050	88	260	91	140	292	3320

* Source: Tetra Tech (1986).

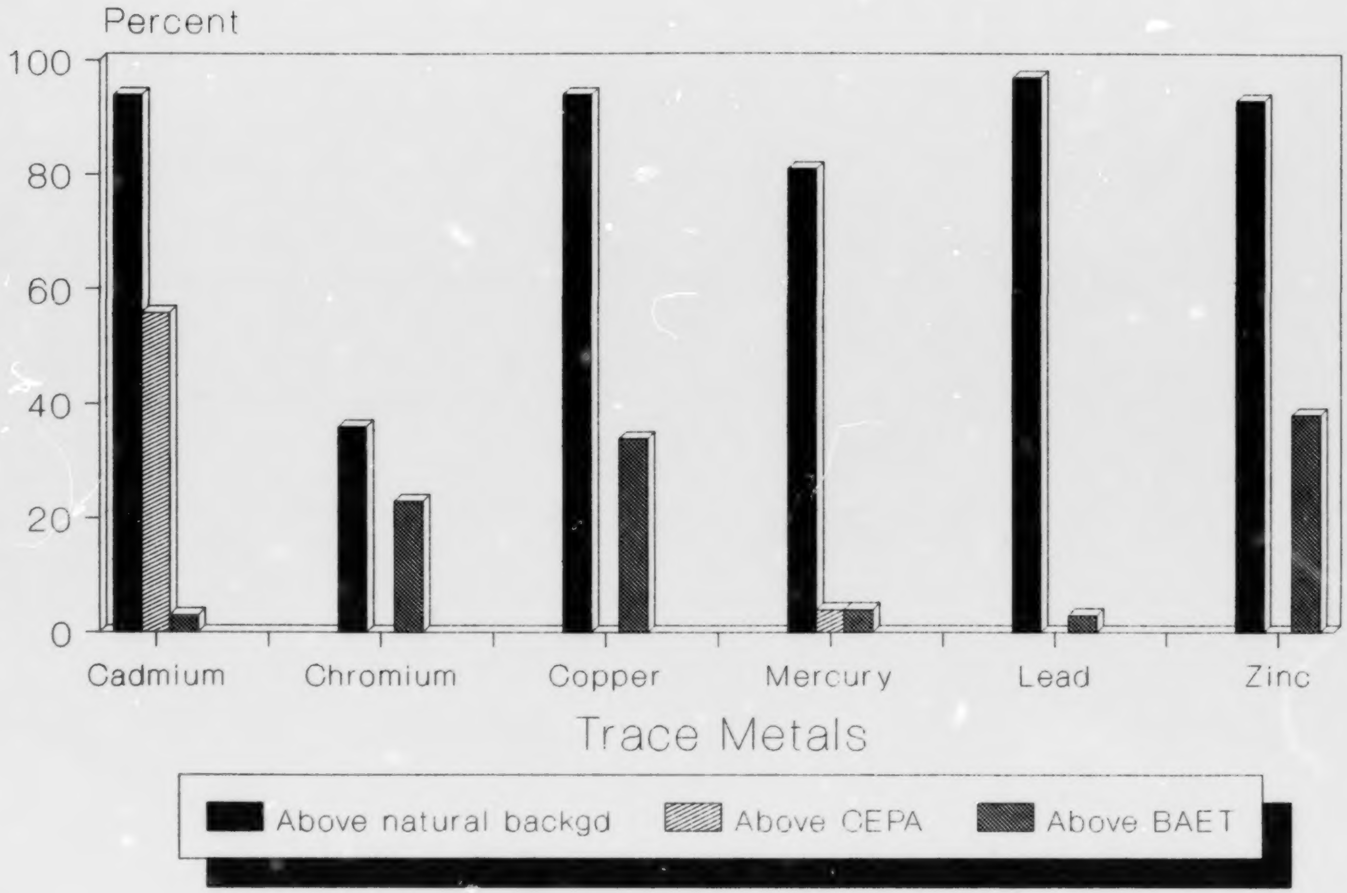


FIGURE 5 PERCENTAGE OF STATIONS ABOVE NATURAL AND BENTHIC AET VALUES

Garrett (1988) indicated that natural concentrations may range from <0.4 to >450 µg/g in ocean sediments with an average of 30 µg/g. Natural levels in Hastings Arm in Northwestern B.C. were between 10 and 19 µg/g (Goyette and Christie, 1982) and in Alice Arm, up to 38 µg/g (Reimer et al., 1985). In Puget Sound, the maximum reference concentration has been given as 17 µg/g, with an estimated average concentration throughout Puget Sound at 9 µg/g (Evans-Hamilton and D.R. Systems, 1987). Arsenic concentrations in Loughborough Inlet in 1987 were <8 µg/g (Appendix C). The majority of sampling sites in Vancouver Harbour were also <8 µg/g. Previous studies in Vancouver Harbour showed high concentrations of arsenic in shore sediments collected near an ore loading facility (≤330 µg/g) and certain shipbuilding/repair facilities in the harbour (≤483 µg/g) (Garrett, 1988).

Unfortunately, in the present study, some analytical problems were experienced with arsenic determinations in the 1985/86 samples. A change from wet to microwave digestion appeared to increase arsenic recovery in standard reference materials (MESS and BCSS) during the initial stages of the changeover (see Appendix A). A corresponding increase also occurred in the field samples making interpretation difficult. Arsenic levels in the samples were not however, considered high enough to warrant re-analysis; concentrations at most sites were below the detection limit of <8.0 µg/g.

In 1987, arsenic concentrations were determined using only microwave digestion procedures. Stations in the outer and inner harbour were below the 8 µg/g detection limit (Appendix C) except for Stations 1 and 2 which ranged from <8 - 20 µg/g. Spillage of metal concentrates during vessel loading and unloading (also refer to sections on copper, lead, and zinc) was the probable source of the arsenic. Concentrations at most stations in Port Moody Arm were <8 µg/g.

Fanning et al. (1989) reported arsenic levels on Sturgeon Banks in the Fraser River estuary at 5.33 - 7.51 µg/g. Roberts Bank values were reported at <8 µg/g (Harding et al., 1988). Arsenic concentrations near the ASARCO smelter in Puget Sound were up to 12,200 µg/g (Evans-Hamilton and D.R. Systems, 1987). In Elliot Bay, near Seattle, the maximum concentration was 280 µg/g (Evans - Hamilton and D.R. Systems, 1987).

Factors other than total concentration of arsenic in the solid phase, may determine its availability. Reimer et al. (1985) found that despite the lower total arsenic concentrations (13.4 µg/g) in marine tailings deposits from Alice Arm compared to the natural sediments (30 µg/g), the soluble arsenic levels in the interstitial water were nearly four times greater. The predominant species of arsenic were As III and IV, two of the more toxic forms of arsenic.

There are no federal limits for arsenic in marine sediments, however, arsenic is classified as a restricted substance under Part IV of the ocean dumping provisions in CEPA. Applications for ocean disposal are reviewed individually. The BAET for arsenic in the Puget Sound area is 85 µg/g (Tetra Tech, 1986), well above the maximum concentrations found in Vancouver Harbour. In most regions of the harbour, arsenic levels in the sediment do not appear to represent a problem.

4.1.1.2 **Cadmium**. Cadmium can originate from a number of urban and industrial sources. It is used in electroplating and metal coating, paint pigments, plastic stabilizers, pesticide catalysts and manufacture of nickel-cadmium batteries (Garrett, 1985b).

The mean concentration of cadmium in Vancouver Harbour sediments ranged from <0.3 to 7.4 µg/g in 1985/86. Computer estimates (SPANS) of cadmium distribution are shown in Figure 6. Mean concentration for each sampling location are mapped in Appendix A (Figure 2) for 1985/86 and Appendix C (Figure 4) for 1987. By comparison, sediment cadmium concentrations reported for the Fraser River estuary on Sturgeon Banks ranged from <0.025 - 0.13 µg/g (Fanning et al., 1989) and 1.0 - 7.0 µg/g off Roberts Bank (Harding et al., 1988). Cadmium concentrations in Puget Sound reached a maximum of 184 µg/g (Evans-Hamilton and D.R. Systems, 1987).

Figure 7 relates average concentration per station (1985/86) to an estimated natural reference level for the harbour (<0.3 µg/g), the 0.6 µg/g

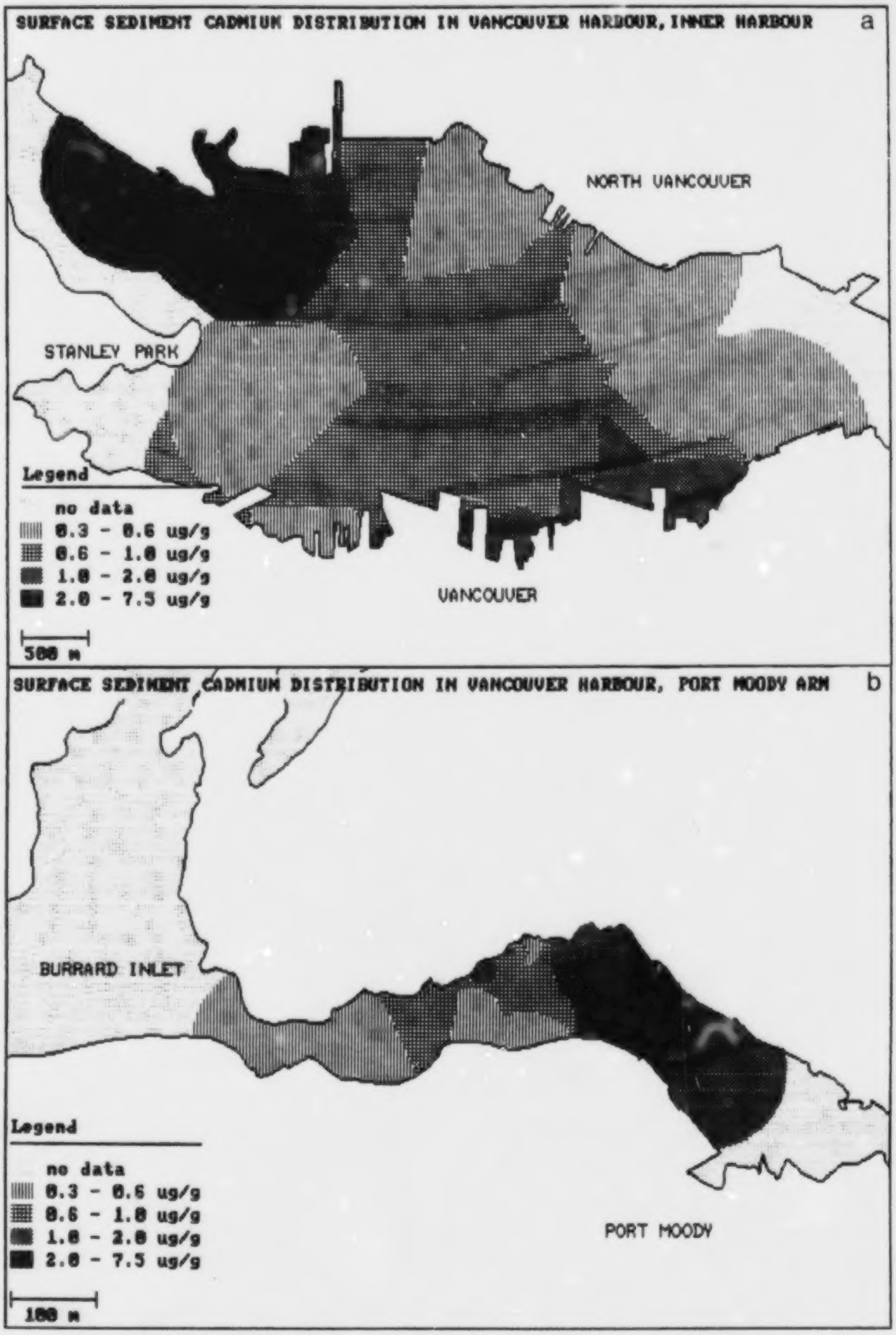

SURFACE SEDIMENT CADMIUM DISTRIBUTION IN VANCOUVER HARBOUR, INNER HARBOUR
a
NORTH VANCOUVER
STANLEY PARK
VANCOUVER
Legend
no data
0.3 - 0.6 ug/g
0.6 - 1.0 ug/g
1.0 - 2.0 ug/g
2.0 - 7.5 ug/g
500 m
SURFACE SEDIMENT CADMIUM DISTRIBUTION IN VANCOUVER HARBOUR, PORT MOODY ARM
b
BURRARD INLET
PORT MOODY
Legend
no data
0.3 - 0.6 ug/g
0.6 - 1.0 ug/g
1.0 - 2.0 ug/g
2.0 - 7.5 ug/g
100 m

FIGURE 6 SURFACE SEDIMENT CADMIUM DISTRIBUTION IN VANCOUVER HARBOUR (1985/86) A) INNER HARBOUR B) PORT MOODY ARM

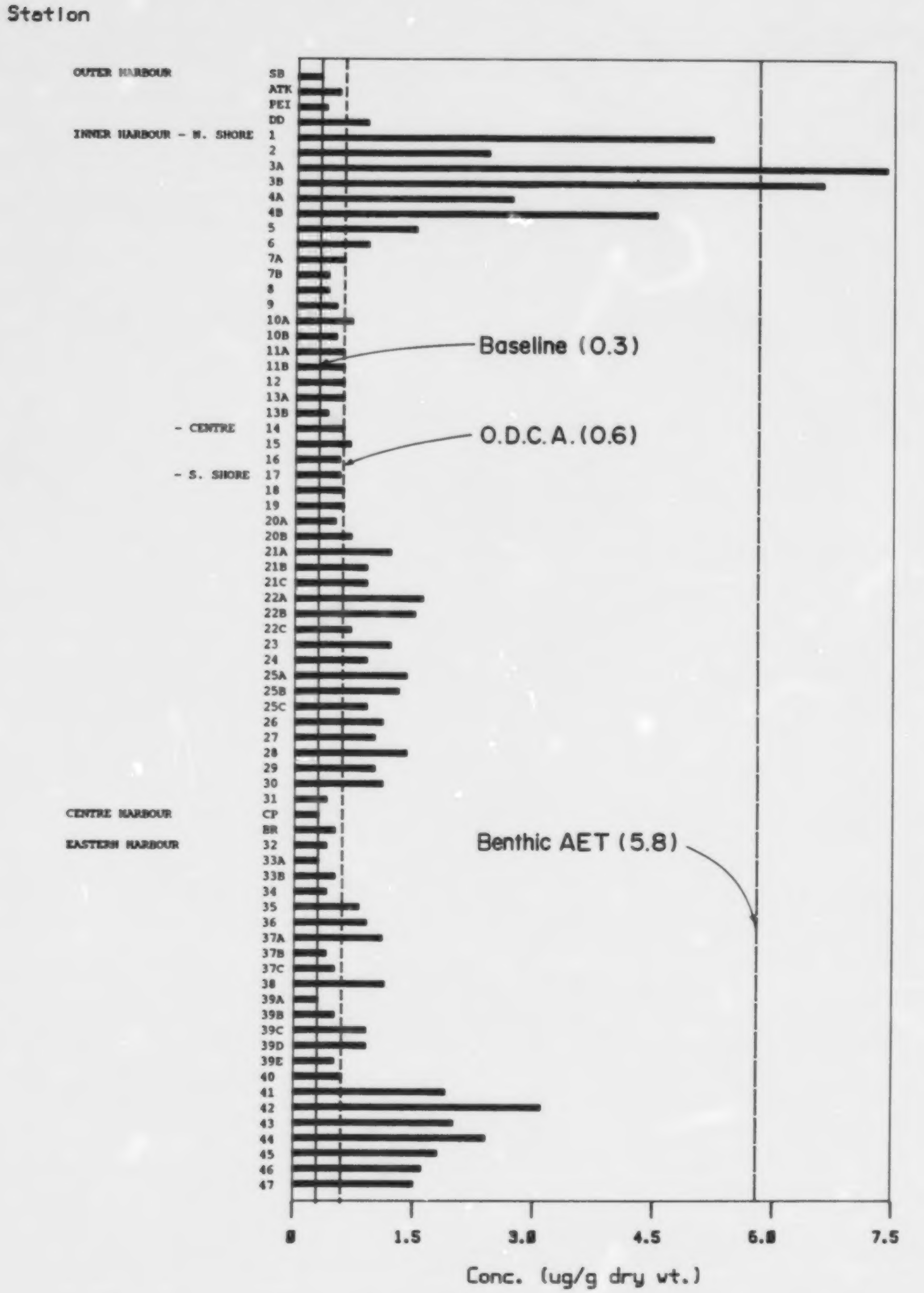


FIGURE 7 Mean Surface Sediment Cadmium Concentrations in Vancouver Harbour (1985-86)

CEPA screening limit for ocean dumping applications, and the Puget Sound BAET, 5.8 µg/g, (Tetra Tech, 1986).

Natural cadmium concentrations for Vancouver Harbour are estimated at <0.3 µg/g based on levels at the Spanish Banks and Cates Park stations (1985/86). In 1988, surface sediment in two samples from Spanish Banks averaged 0.09 µg/g (Goyette, unpublished data). At two sites in Loughborough Inlet, in 1987 concentrations averaged 0.31 and 0.56 µg/g, respectively (Appendix C). Maximum and average reference levels for Puget Sound have been given as 1.9 µg/g and 0.3 µg/g, resepctively, (Evans-Hamilton and D.R. Systems, 1987). Harding and Thomas (1987) found cadmium levels at unpolluted coastal inlets to range from 0.9 µg/g to 1.4 µg/g.

Including 1987 data, concentrations in the outer harbour ranged from <0.3 - 0.9 µg/g, average 0.4 µg/g at Station PEI (6 surveys). In 1988, levels in a 157 cm. core sample taken at Station PEI were 0.09 - 0.31 µg/g (unpublished data). The lowest concentration was recorded at 40 - 42 cm.

Mean cadmium concentration obtained from 44 sites in the inner harbour in 1985/86 was 1.35 ± 1.59 µg/g. Higher levels (1.5 and 7.4 µg/g) were confined to the north shore of the inner harbour at Stations 1 - 5 and along the South shore (Stations 21 - 30) where mean concentrations were from 1.0 - 1.6 µg/g (Figure 7). Similar results were obtained in 1987 at Stations 1, 2, 22A and 25A (Appendix C - Figure 2). Offshore levels in the inner harbour were generally below 1.0 µg/g. In 1980 and 1981, Garrett found cadmium levels ranging from 0.4 to 24.5 µg/g along the foreshore near Stations 1 and 2, and ≤11.9 µg/g inshore from Station 5 (unpublished data).

Mean concentration from 23 sites in Port Moody Arm in 1985/86 was 1.06 ± 0.76 µg/g (range, <.3 - 3.1 µg/g) and slightly higher in 1987 at 2.14 ± 1.91 µg/g (range, 0.66 - 10.22 µg/g) (32 sites). Two noticeably high values (4.89 and 10.22 µg/g) were observed in samples from Stations 34C and 36C in 1987. Samples were re-analyzed and results confirmed. Lower concentrations generally occurred near the entrance to the arm and increased towards the head (Stations 42 to 47) near the Pacific Coast Terminals

(Appendix A - Figure 2). Bourne (1974) reported a range of 0.1 to 3.3 µg/g from 70 sampling stations throughout Port Moody Arm. He also observed lower values (0.1 to 0.9 µg/g) near the entrance and in the upper portions of the arm, and higher levels along the nearshore areas of the middle portion.

In 1988, a core sample taken from the middle of Port Moody Arm (Station 39C) was within 1.2 - 1.7 µg/g throughout an 118 cm core measured at 10 cm intervals (Goyette, unpublished data). A similar pattern was evident in a core sample taken near the entrance to the arm (Station 33B) except a sharp increase to 3.5 µg/g which occurred at 70 cm. in the core. A corresponding increase also occurred with copper, lead and zinc concentrations. Possible anthropogenic sources of cadmiuim in Port Moody Arm include the oil refinery at Ioco, bulk loading operations at Pacific Coast Terminals, stormwater discharges, and combined sewer overflows. A detailed inventory on the various industrial and urban discharges would determine potential sources, more precisely.

Although the sources of cadmium in Port Moody Arm appears to be largely anthropogenic, natural sources also need to be considered. Pedersen et al., (1988), found that cadmium (and molybdenum) enrichment in a west coast inlet resulted from the natural addition from the overlying seawater into organic-rich, anoxic sediments. The strong hydrogen sulfide odour and black appearance of the sediment samples at most locations in Port Moody Arm suggest that similar conditions exist in Port Moody Arm.

In 1985/86, 90% of the sample sites in the harbour were above the natural level estimated for Vancouver Harbour (<0.3 µg/g), 56% were above the screening limit for ocean disposal (0.6 µg/g), and 5% were above the Puget Sound BAET (5.8 µg/g). In 1987, all concentrations in Port Moody Arm exceeded the 0.6 µg/g CEPA Ocean Dumping Screening level, although most offshore areas were below 1.0 µg/g. Control of cadmium sources is needed to avoid exceeding CEPA ocean dumping limits on dredge material intended for ocean disposal and to minimize the potential for uptake and toxicological effects to marine species. Spillage from metal concentrate loading facilities, oil refinery operations, and combined sewer overflows appear to be the primary sources of cadmium to the harbour.

4.1.1.3 **Chromium**. Chromium is used in electroplating, pigment and dying processes, tanning, and the production of ferroalloys; it may be also discharged to municipal sewer systems from other sources. Chromium can be highly toxic to marine organisms; the degree of toxicity depends on its valence state. Hexavalent chromium (Cr VI) for example is more toxic than trivalent chromium (Cr III). In the marine environment Cr IV can be reduced to Cr III by a sulphate reducing bacteria (Smillie et al., 1984; Jenkins, 1982) which has less biological activity (Langard, 1980). Chromate solutions have induced gill hyperplasia in rainbow trout (Temmink et al., 1983), and caused carcinogenic effects in mammals Langard (1980).

Mean chromium concentrations in the harbour in 1985/86, ranged between 25 and 267 µg/g. Computer estimated (SPANS) chromium distribution in the surface sediments are shown in Figure 8. Mean concentration for each sampling location are mapped in Appendix 3 (Figure 3) for 1985/86 and Appendix C (Figure 5) for 1987. This can be compared to chromium levels reported for Sturgeon Banks in the Fraser River estuary, 30 - 63 µg/g (Fanning et al., 1989). Harding et al. (1988) found concentrations off Roberts Bank ranging from 30.4 to 68.7 µg/g. Maximum concentration in Puget Sound has been reported at 129 µg/g (Tetra Tech, 1986).

Figure 9 relates average concentration per station (1985/86) to the maximum natural reference level (50 µg/g) for Vancouver Harbour, and Puget Sound BAET (59 µg/g - Tetra Tech, 1986). Reference chromium level for Vancouver Harbour has been estimated from the mean concentration at Spanish Banks in 1985/86 (Appendix A) and results from a series of samples taken in the outer harbour in 1988 (unpublished data). Concentrations from two sites in Loughborough Inlet in 1987 averaged 33.8 and 38.4 µg/g, respectively (Appendix C). The reference level for Puget Sound, based on 7 nonurban sites, has been given as 54 µg/g (Tetra Tech, 1986). Chapman et al. (1986) reported a reference level for the Fraser River estuary at 48 µg/g.

Chromium concentrations throughout most of Vancouver Harbour sediments were <50 µg/g. The inner harbour averaged 42.2 ± 10 µg/g (range,

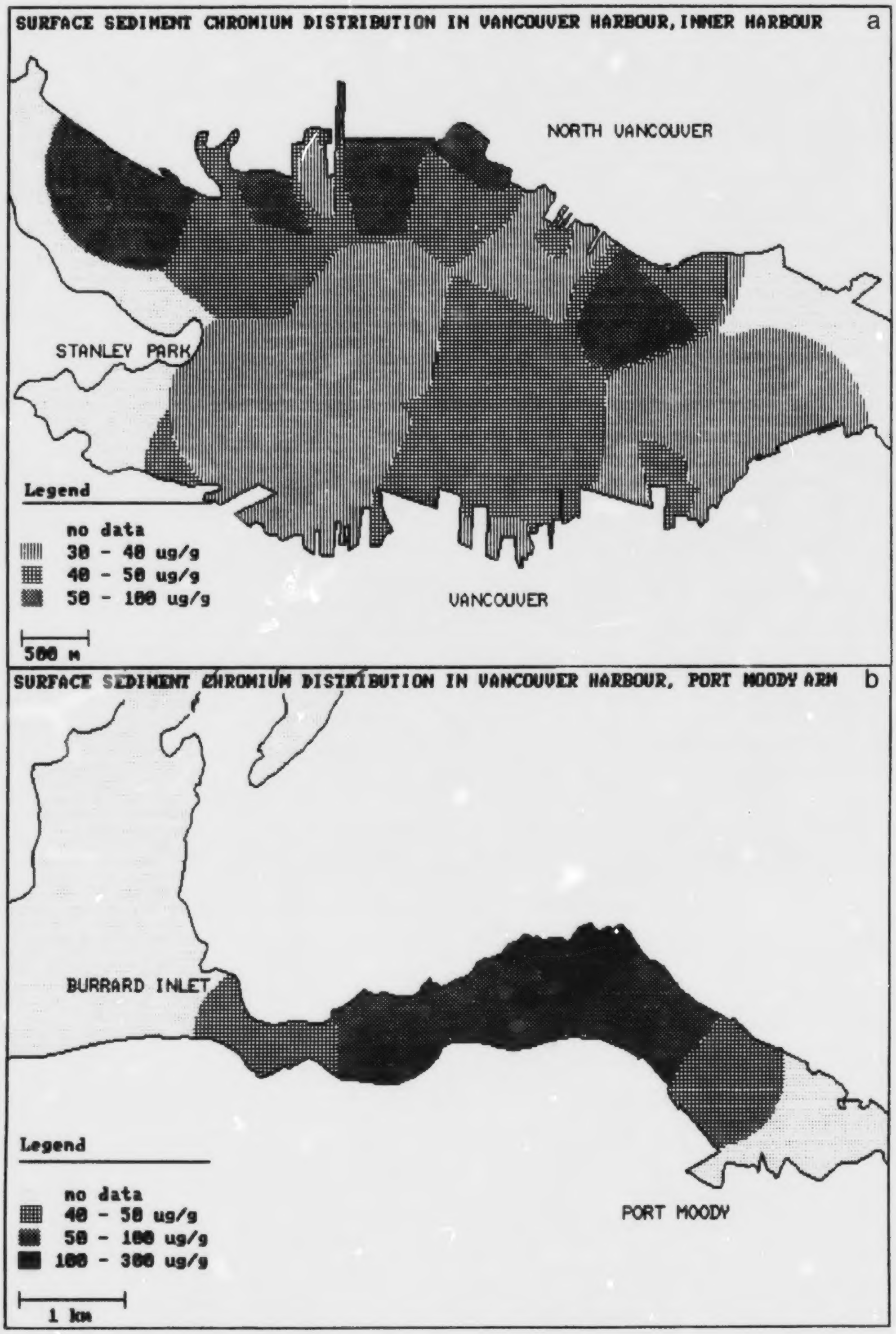
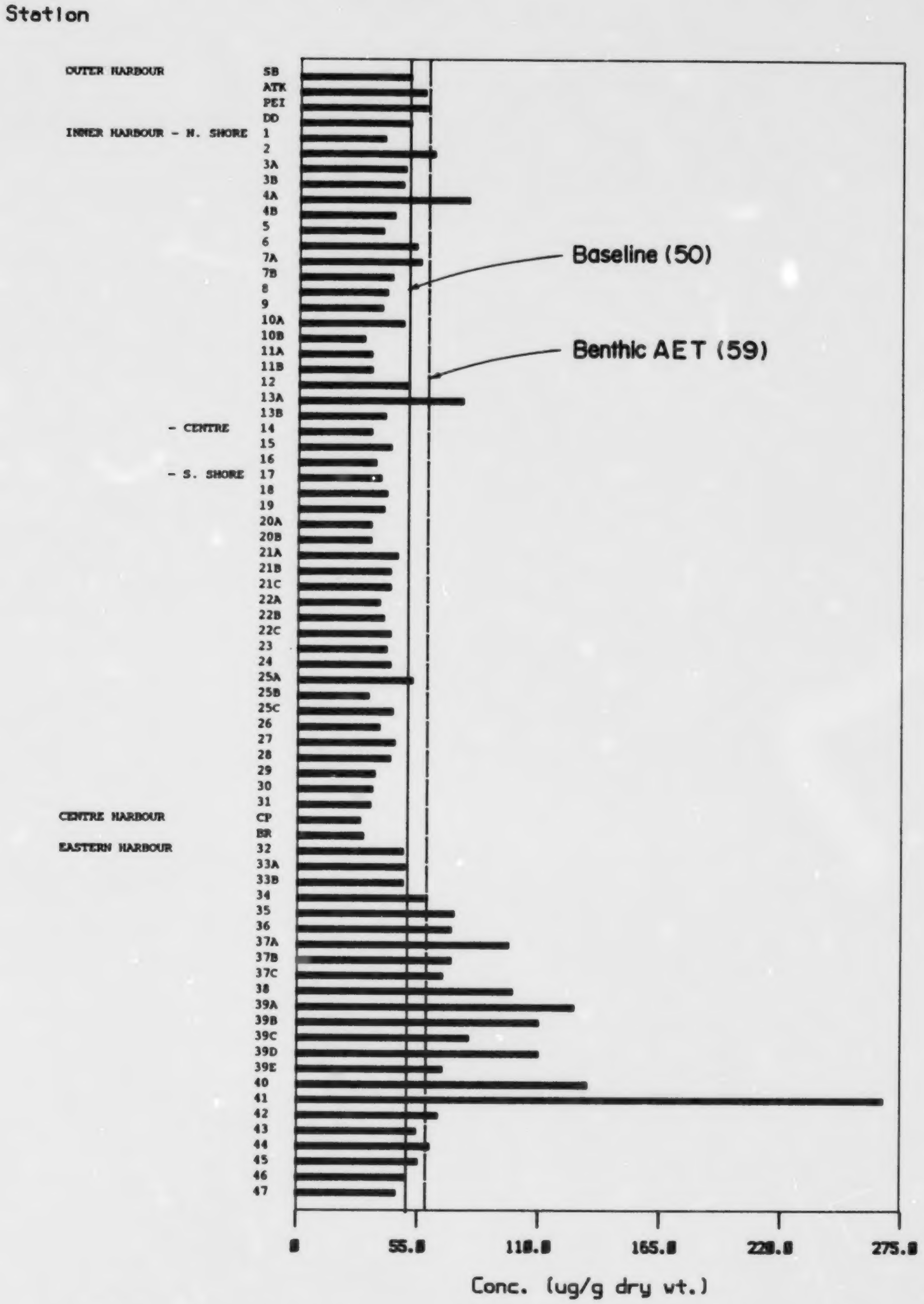

SURFACE SEDIMENT CHROMIUM DISTRIBUTION IN VANCOUVER HARBOUR, INNER HARBOUR
a
NORTH VANCOUVER
STANLEY PARK
VANCOUVER
Legend
no data
30 - 40 ug/g
40 - 50 ug/g
50 - 100 ug/g
500 m
SURFACE SEDIMENT CHROMIUM DISTRIBUTION IN VANCOUVER HARBOUR, PORT MOODY ARM
b
BURRARD INLET
PORT MOODY
Legend
no data
40 - 50 ug/g
50 - 100 ug/g
100 - 300 ug/g
1 km

FIGURE 8 SURFACE SEDIMENT CHROMIUM DISTRIBUTION IN VANCOUVER HARBOUR (1985/86) A) INNER HARBOUR B) PORT MOODY ARM



Baseline (50)

Benthic AET (59)

FIGURE 9 Mean Surface Sediment Chromium Concentrations in Vancouver Harbour (1985-86)

29 - 77 µg/g). Levels in Port Moody Arm, ranged from 45 µg/g, near the head of the arm (Station 47) up to 267 µg/g, off the Ioco refinery (Station 41), the maximum level in Vancouver Harbour. The overall mean concentration in Port Moody Arm in 1985/96 was 82.2 ± 47.8 µg/g and 69.2 ± 17.1 µg/g (range, 50.6 - 128.0 µg/g) in 1987. The maximum concentration in 1987 again was found at Station 41 (128 µg/g).

The major source of chromium in the harbour appears to be the Ioco oil refinery in Port Moody Arm. The GVRD combined sewer overflows in the inner harbour (Stations 25 and 30) were not a significant source. Except for Port Moody Arm, chromium levels in the harbour do not indicate any major areas of concern. Levels found in Port Moody Arm and their relationship to fish liver lesions needs further investigations.

4.1.1.4 **Copper**. Loading facilities for bulk metal concentrates, shipyards (anti-fouling paints), blasting abrasives (smelter slags), and herbicides are major urban sources of copper to the marine environment. Although copper is an essential element in biological processes, it can be highly toxic to marine organisms. Copper can also act synergistically with other metals, such as zinc. Lewis and Cave (1982) provide a detailed review of the beneficial and detrimental effects of copper to marine and estuarine organisms.

Of all the metals examined, copper showed the most widespread contamination. Mean sediment concentrations for the entire study area in 1985/86, ranged from 48 µg/g to 4353 µg/g. Computer estimated (SPANS) copper distribution in the surface sediments in the inner harbour and Port Moody Arm (1985/86) are shown in Figure 10. Mean concentration per station are also shown by maps contained in Appendix A (Figure 4) for 1985/86 and Appendix C (Figure 6) for 1987. By comparison, sediment copper levels in the Fraser River estuary (Sturgeon Bank) have been reported as 9.8 - 39.3 µg/g (Fanning et al., 1989) and 14.9 - 30.7 µg/g off Roberts Bank (Harding et al., 1988). Concentrations in Puget Sound ranged from 3 to 14,300 µg/g (Evans-Hamilton and D.R. Systems, 1987), the latter recorded near the ASARCO copper smelter. Nearshore areas in Elliot Bay and Commencement Bay ranged

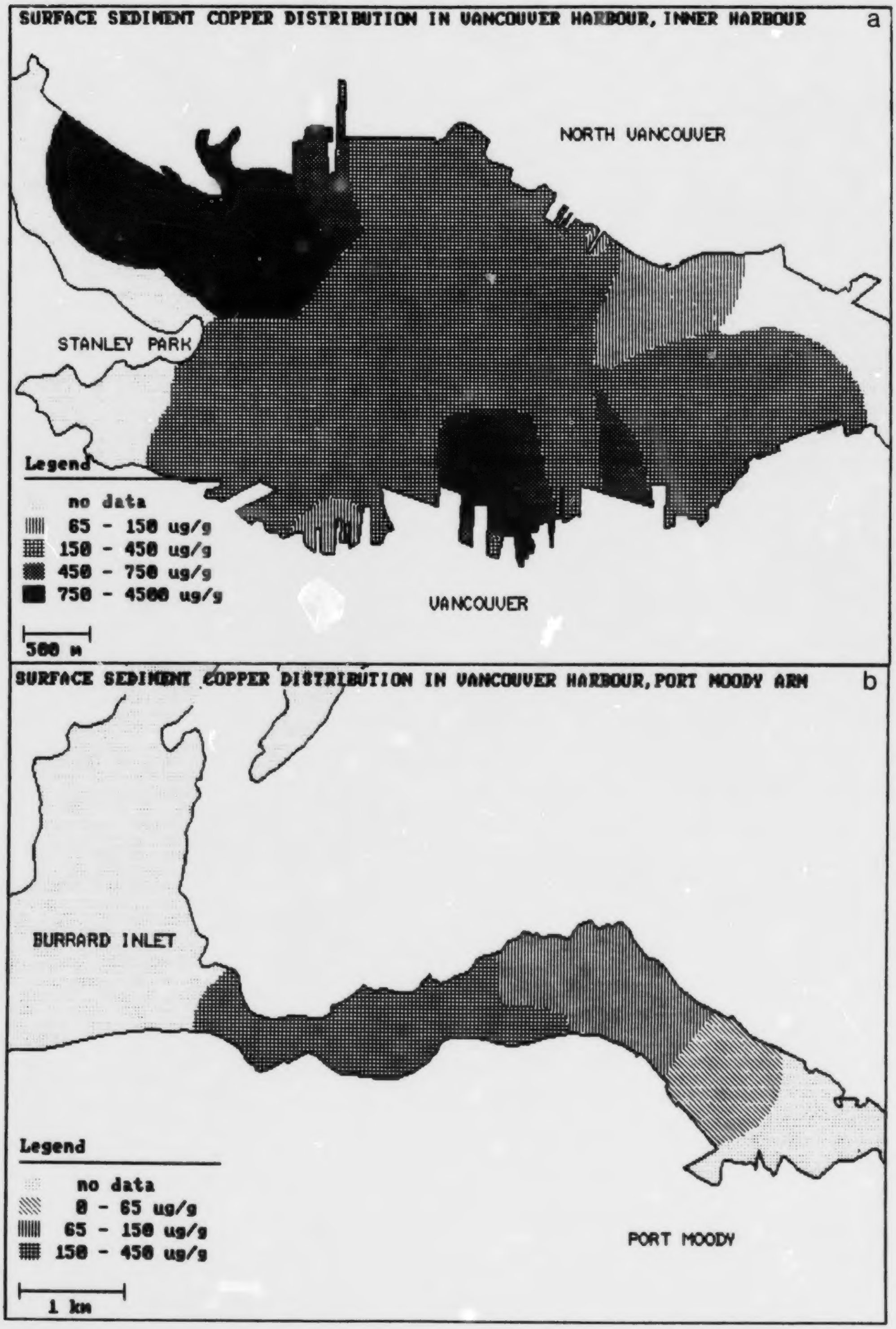

SURFACE SEDIMENT COPPER DISTRIBUTION IN VANCOUVER HARBOUR, INNER HARBOUR
a
NORTH VANCOUVER
STANLEY PARK
VANCOUVER
Legend
no data
▥ 65 - 150 ug/g
▦ 150 - 450 ug/g
▩ 450 - 750 ug/g
■ 750 - 4500 ug/g
500 m
SURFACE SEDIMENT COPPER DISTRIBUTION IN VANCOUVER HARBOUR, PORT MOODY ARM
b
BURRARD INLET
PORT MOODY
Legend
no data
▨ 0 - 65 ug/g
▥ 65 - 150 ug/g
▦ 150 - 450 ug/g
1 km

FIGURE 10 SURFACE SEDIMENT COPPER DISTRIBUTION IN VANCOUVER HARBOUR (1985/86) A) INNER HARBOUR B) PORT MOODY ARM

from 23 - 1679 µg/g and 20 - 14,300 µg/g, respectively.

Figure 11 illustrates the relationship of the average concentration at each sampling location in 1985/86 to the natural reference level (65 µg/g) and Puget Sound BAET (310 µg/g - Tetra Tech, 1986). Natural sediment copper levels for Vancouver Harbour are estimated to be <65 µg/g from 1985/86 results from Spanish Banks and Cates Park and a core sample from PEI in 1988, in which copper concentrations ranged from 62 µg/g at 14 - 16 cm. to 40 µg/g at core depth (157 cm) (Goyette, unpublished data), essentially reflecting the natural levels below the contaminated surface layer. Copper levels in Loughborough Inlet (2 sites) in 1987 averaged 64 µg/g (Appendix C). Harding and Thomas (1987) reported baseline levels for Barkley Sound, Quatsino Sound, and Surf Inlet between 23.9 and 68.8 µg/g. Reference levels for Puget Sound are given as 74 µg/g (Evans-Hamilton and D.R. Systems, 1987).

Average copper concentrations in the outer harbour, ranged from 65 - 504 µg/g; elevated levels (>241 µg/g) were observed out as far west as Point Atkinson, the outermost sampling site. In 1988, concentrations at this site were 221 - 227 µg/g (Goyette, unpublished data). The Dundarave site (DD) averaged 504 µg/g in 1985/86 (Appendix A, Figure 4) and ranged from 420 - 486 µg/g in 1988 (Goyette, unpublished data).

Within the inner harbour (1985/86) concentrations ranged from 90 - 4353 µg/g. Maximum levels of 4083 µg/g and 4353 µg/g, were observed at Station 1 and 2, respectively, off the concentrate loading dock at Vancouver Wharves. In 1987, concentrations at these two sites were to 9760 µg/g and 6547 µg/g, respectively. The impact from this single source extended for a considerable distance into the outer harbour (ATK and DD Stations). Eastward along the north shore of the inner harbour, concentrations ranged from 439 to 1967 µg/g. Strong tidal currents through First Narrows would account for the copper distribution in these areas (Canadian Hydrographic Service, 1981).

Elevated copper levels were also found along most of the south shore of the inner harbour, particularly at Station 22A. Copper concentrate

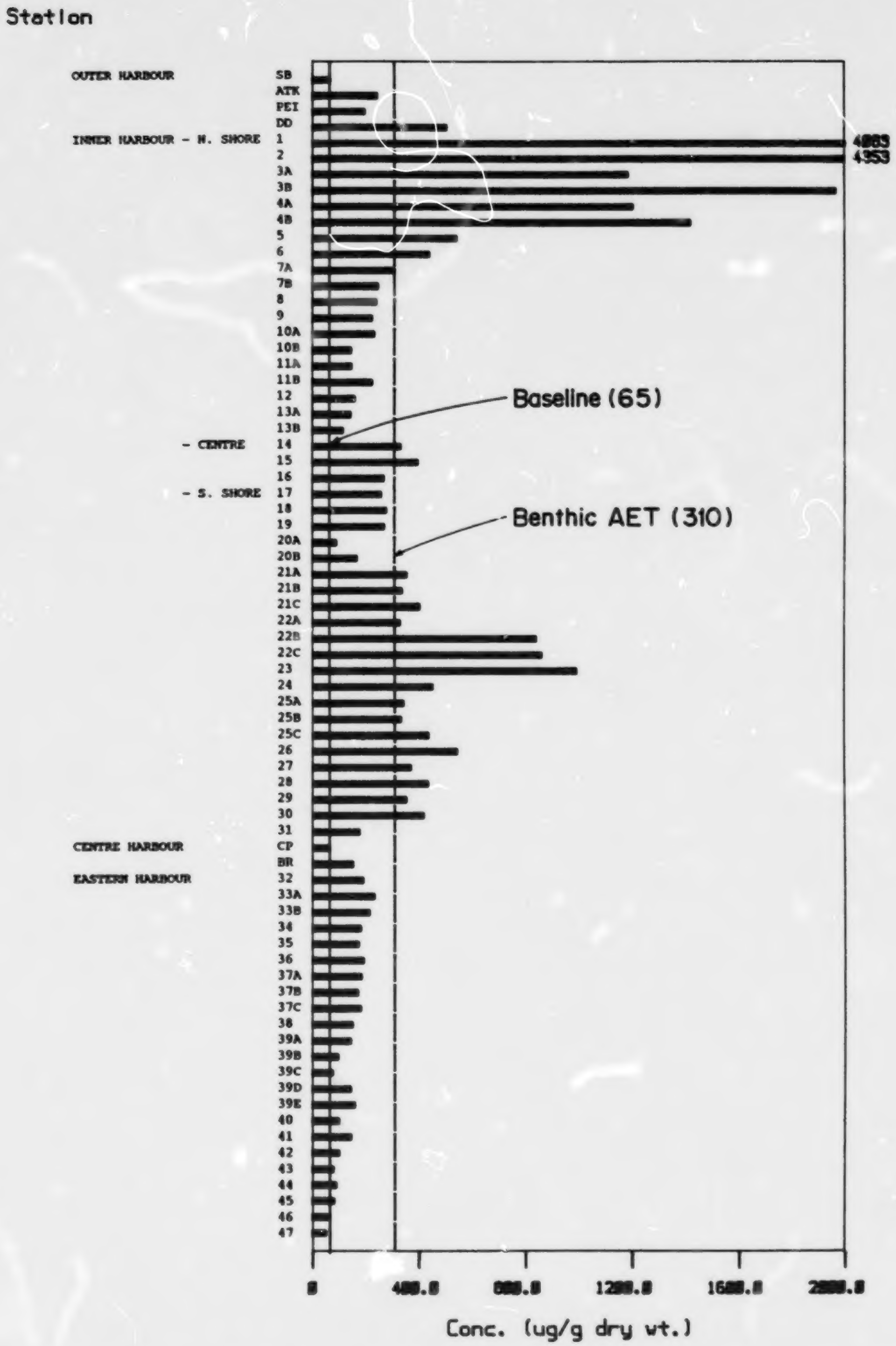


FIGURE 11 Mean Surface Sediment Copper Concentrations in Vancouver Harbour (1985-86)

had been temporarily stored on a nearby dock facility after the June 1986 survey. Concentrations increased from 328 µg/g before storage (Appendix A) to 1240 µg/g in 1987 (Appendix C). Spillage during the vessel loading probably accounts for most of the increase in copper concentration in the marine sediments. In general, urban and industrial sources of copper have been sufficient to cause all increase throughout most of the inner harbour. Copper levels in 1985/86 at Stations 14 and 15, located along the centre of the harbour, averaged 333 µg/g and 465 µg/g, respectively, well above the natural baseline.

Copper concentrations in Port Moody Arm were generally lower compared to an inner harbour mean of 683 µg/g. The 1985/86 average was 138 ± 53 µg/g (range, 48 - 234 µg/g), 1987 was 154 ± 43 µg/g (range, 62 - 238 µg/g). Bourne (1974) reported a mean concentration of 66 µg/g from 70 stations in Port Moody Arm (range 9.5 - 162 µg/g). The distribution pattern did not reveal any specific anthropogenic sources of copper within Port Moody Arm in either 1985/86 or 1987, although concentrations tended to increase towards the entrance to the arm, suggesting possible sources from outside the arm.

Overall, 94% of the stations sampled in Vancouver Harbour in 1985/86 exceeded the reference concentration and 37% were above the Puget Sound BAET. Although there are no federal regulatory limits for copper, it is considered a restricted substance under the ocean dumping provision of CEPA and applications are considered individually. Attention to the various anthropogenic sources in the harbour is required if sediment copper levels are expected to improve significantly in the future, particularly with bulk metal concentrate handling, stormwater discharges and combined sewer overflows. Dockside vessel repairs, particularly along the south shore of the inner harbour may also be a source of copper contamination.

4.1.1.5 **Mercury**. According to Garrett (1985a), the application of mercury is extensive and diverse in industry. Uses which would likely affect the harbour are in electrical equipment, scientific instruments, paints, pesticides, dental amalgams, pharmaceuticals and chemical manufacturing.

Waste from these sources would be present largely in municipal sewage and urban runoff.

Computer estimated (SPANS) mercury distribution in the surface sediments of the inner harbour and Port Moody Arm (1985/86) is shown in Figure 12. Mean concentration per station are shown on maps in Appendix A (Figure 6) for 1985/86 and Appendix C (Figure 8) for 1987. Mercury concentrations in subtidal sediments from the Fraser River estuary (Roberts Bank), by comparison, have been reported between 0.087 and 0.253 µg/g (Harding et al., 1988), 0.023 and 0.11 µg/g at Sturgeon Bank (Fanning et al., 1989). Levels in Puget Sound have been reported between 1 - 100 µg/g (Evans-Hamilton and D.R. Systems, 1987).

Figure 13 compares average concentration at each sampling location in 1985/86 to a natural reference level (0.2 µg/g), CEPA Ocean Dumping screening limit (0.75 µg/g), and Puget Sound BAET (0.88 µg/g - Tetra Tech, 1986). Reference levels for sediment mercury in Vancouver Harbour are estimated to be <0.20 µg/g. Concentrations at the Spanish Banks and Cates Park stations, averaged 0.14 µg/g and 0.10 µg/g, respectively. In 1988, mercury levels at the former station were 0.11 - 0.13 µg/g (Goyette, unpublished data). In Loughborough Inlet, mercury concentrations averaged 0.12 µg/g (Appendix C). Reference concentrations for Puget Sound have been given as 0.28 µg/g (Evans-Hamilton and D.R. Systems, 1987), and 0.08 µg/g (Chapman et al., 1986).

Sediment mercury concentrations >1.0 µg/g generally warrant further investigation since they are often associated with elevated levels in aquatic biota tissue (Garrett 1985a). All mercury values in the harbour were below this limit except for stations 25A and 30, along the south shore of the inner harbour (Figure 3). Both sites were adjacent to combined sewer overflows at Clark Drive/Vernon Relief and Victoria Drive, respectively. Concentrations at these two locations were 4.6 and 2.2 µg/g, respectively, well above the baseline level estimated for the harbour. Mercury concentration in 1987 at Station 25A averaged 2.5 µg/g. The sediment samples from Station 25A were mainly raw sewage, indicating that municipal

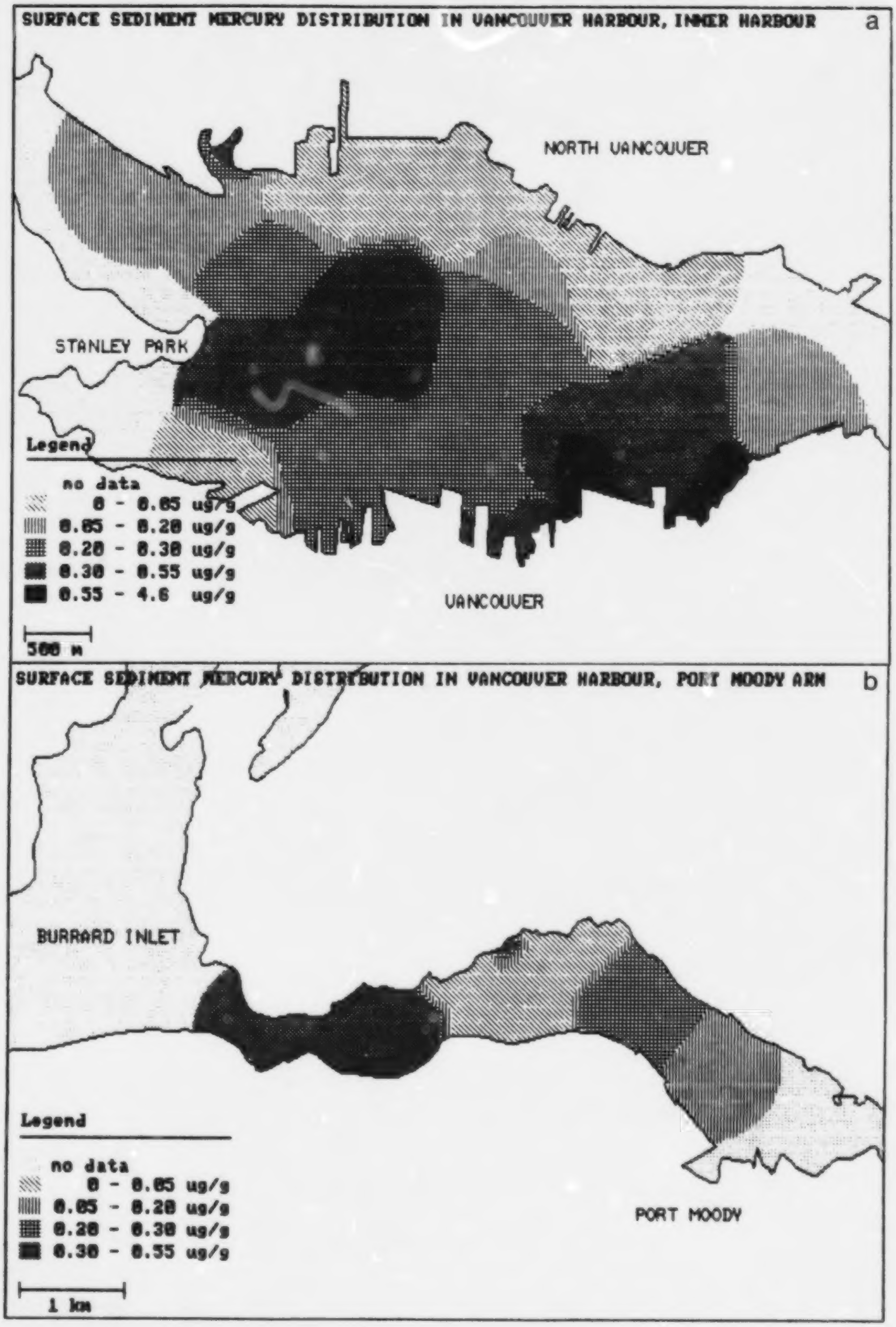

SURFACE SEDIMENT MERCURY DISTRIBUTION IN VANCOUVER HARBOUR, INNER HARBOUR
a
NORTH VANCOUVER
STANLEY PARK
Legend
no data
0 - 0.05 ug/g
0.05 - 0.20 ug/g
0.20 - 0.30 ug/g
0.30 - 0.55 ug/g
0.55 - 4.6 ug/g
VANCOUVER
500 m
SURFACE SEDIMENT MERCURY DISTRIBUTION IN VANCOUVER HARBOUR, PORT MOODY ARM
b
BURRARD INLET
Legend
no data
0 - 0.05 ug/g
0.05 - 0.20 ug/g
0.20 - 0.30 ug/g
0.30 - 0.55 ug/g
PORT MOODY
1 km

FIGURE 12 SURFACE SEDIMENT MERCURY DISTRIBUTION IN VANCOUVER HARBOUR (1985/86) A) INNER HARBOUR B) PORT MOODY ARM

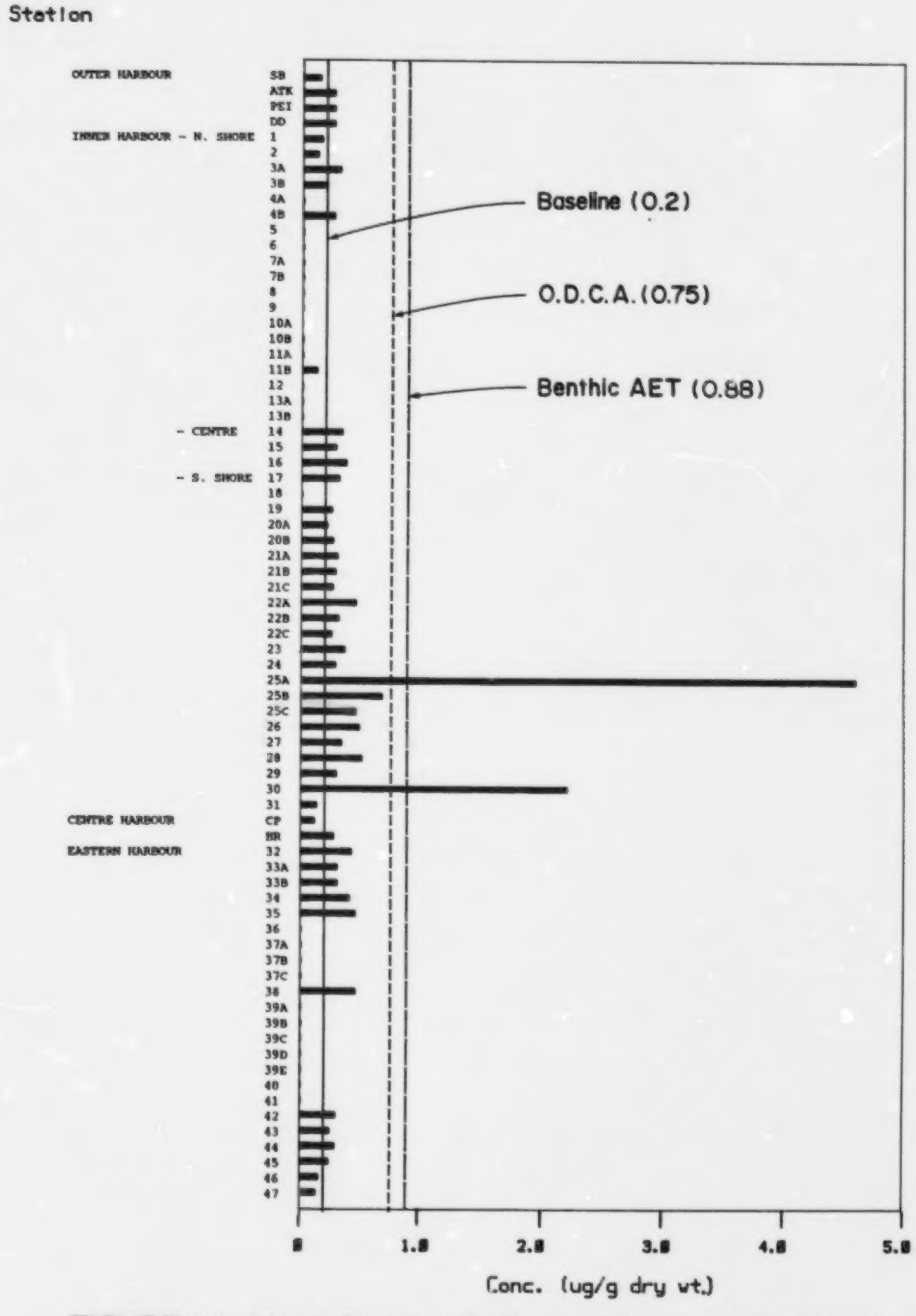


FIGURE 13 Mean Surface Sediment Mercury Concentrations in Vancouver Harbour (1985-86)

effluents were the major source of mercury. Another potential source may include shipyard and repair facilities located near Station 30.

Mercury concentration in the inner harbour in 1985/86 (34 sites) averaged 0.48 µg/g. In Port Moody Arm, concentrations averaged 0.30 ± .11 µg/g in 1985/86 (12 sites) and 0.32 ± .08 µg/g in 1987 (32 sites). Foreshore sampling along the north shore in 1984 showed mercury levels up to 0.45 µg/g adjacent to Vancouver Wharves, 1.7 µg/g near Vancouver Shipyards, and up to 6.4 µg/g near the Burrard Yarrows shipyards (Garrett, unpublished data). The present study did not find any evidence of mercury contamination extending to nearshore or offshore sites (Stations 1-4B & 11B) adjacent to areas sampled by Garrett.

Of the 48 stations sampled for sediment mercury in 1985/86, 81% were above the estimated reference level for the harbour (0.20 µg/g). Mercury is considered a restricted substance under the CEPA ocean dumping provisions and the maximum allowable limit is 0.75 µg/g in the solid phase and the Puget Sound BAET for mercury is given as 0.88 µg/g; most stations are below these levels. The combined sewer overflows along the south shore of the inner harbour are considered the major mercury contributors.

4.1.1.6 Lead. According to Garrett (1985b), the source of lead to the aquatic environment is primarily anthropogenic, either directly or by atmospheric deposition. In an urban environment, primary sources might be metal plating operations, gasoline combustion, battery disposal, paint wastes, various consumer products, and spillage from metal concentrate loading.

Elevated lead levels were found in most sediment samples in Vancouver Harbour; mean concentrations ranged from 12 - 15,420 µg/g. Computer estimated (SPANS) lead distribution in 1985/86 are shown in Figure 14. Mean concentrations per station are mapped in Appendix A (Figure 8) for 1985/86 and Appendix C (Figure 10) for 1987. By comparison, sediment lead concentrations in Puget Sound were reported up to 10,635 µg/g (Evans-Hamilton and D.R. Systems, 1987); those along the Seattle waterfront

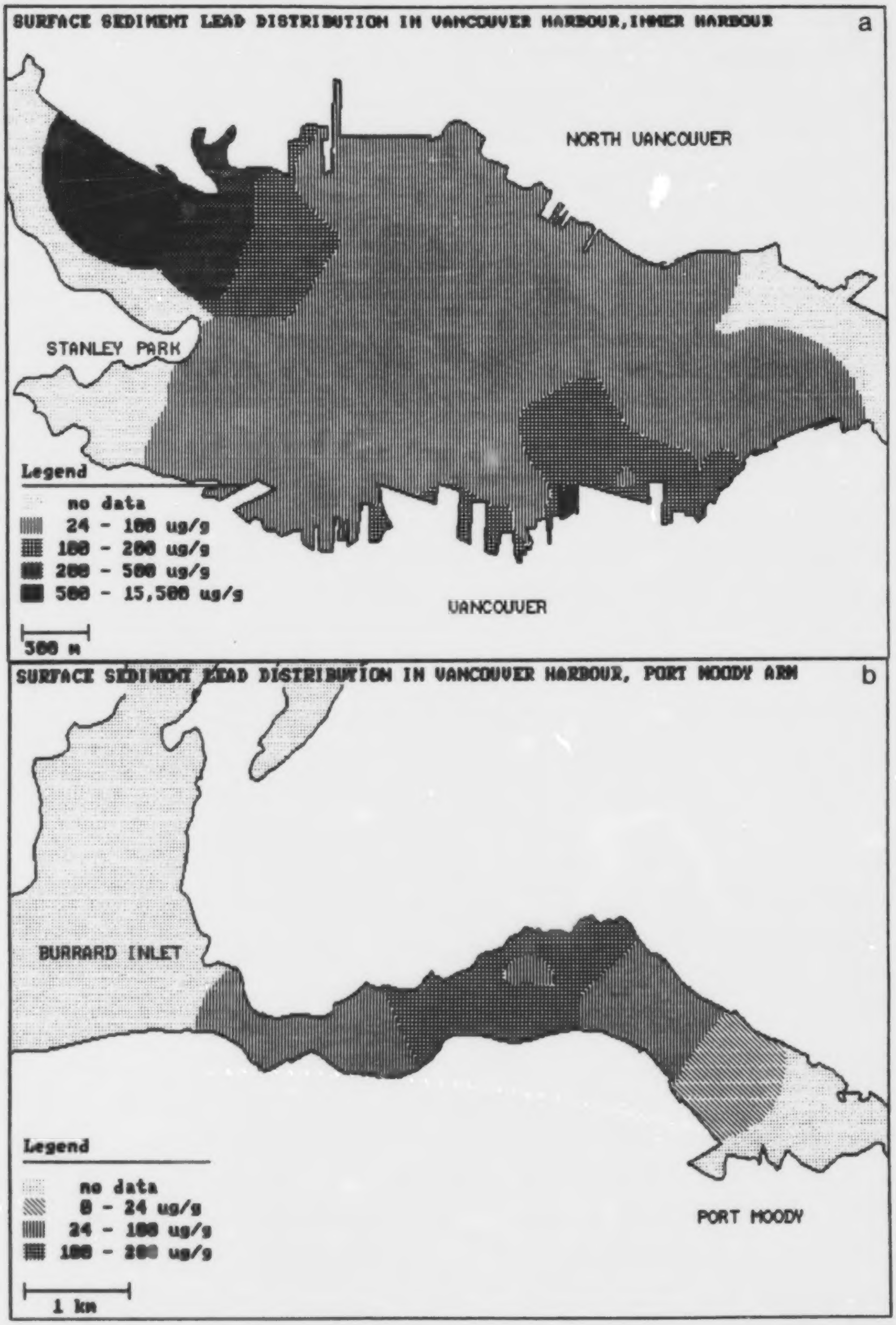

SURFACE SEDIMENT LEAD DISTRIBUTION IN VANCOUVER HARBOUR,INNER HARBOUR
a
NORTH VANCOUVER
STANLEY PARK
VANCOUVER
Legend
no data
24 - 100 ug/g
100 - 200 ug/g
200 - 500 ug/g
500 - 15,500 ug/g
500 m
SURFACE SEDIMENT LEAD DISTRIBUTION IN VANCOUVER HARBOUR, PORT MOODY ARM
b
BURRARD INLET
PORT MOODY
Legend
no data
0 - 24 ug/g
24 - 100 ug/g
100 - 200 ug/g
1 km

FIGURE 14 SURFACE SEDIMENT LEAD DISTRIBUTION IN VANCOUVER HARBOUR (1985/86) A) INNER HARBOUR B) PORT MOODY ARM

averaged 1700 µg/g. In the Fraser River estuary, concentrations on Sturgeon Bank were reported at 2.99 - 12.3 µg/g (Fanning et al., 1989) and <3 µg/g in sediment samples taken from Roberts Bank (Harding et al., 1988). Chapman (1986) reported lead concentrations at 6.6 - 18.5 µg/g in sediment samples taken near outfall from the Iona sewage treatment plant.

Figure 15 illustrates the relationship of the average concentration at each sampling location in 1985/86 to an estimated natural reference level in Vancouver Harbour (<24 µg/g), and Puget Sound BAET (300 µg/g - Tetra Tech, 1986). In 1985/86, the mean concentration at the Spanish Banks was 17 µg/g. In 1988, it was 18.3 - 18.5 µg/g (Goyette, unpublished data). Mean lead concentrations in Loughborough Inlet sediment in 1987 was 22 µg/g (Appendix C). In Puget Sound, the reference level for lead has been given as 24 µg/g (Evans- Hamilton and D.R. Systems, 1987); similar natural levels are reported for Alice Arm (Goyette and Christie, 1982). Chapman et al. (1986) gave a reference level for the Fraser estuary at 7.8 µg/g.

In the outer harbour, values ranged from 17 - 67 µg/g. Mean concentration in the inner harbour in 1985/86 ranged from 39 - 15,420 µg/g (Mean 468 ± 2308 µg/g). As for copper, highest lead concentrations were found at Stations 1 and 2, off the Vancouver Wharves concentrate loading docks. In 1985/86, mean lead levels at these sites were 15,420 and 585 µg/g, respectively and in 1987, 2060 and 1023 µg/g, respectively. Between 1981 and 1983, Garrett found concentrations of 9.3 to 1670 µg/g in foreshore samples taken near Vancouver Wharves (unpublished data). During the same period, shoreline lead levels adjacent to Vancouver Shipyards were 5 - 624 µg/g and at Burrard Yarrows shipyard, 3 - 1710 µg/g. Although substantually lower than those found at Stations 1 and 2, elevated levels were also found along the south shore of the inner harbour during the present study. Concentrations adjacent to the GVRD Clark Drive/Vernon Relief combined sewer overflows were 241 and 342 µg/g, respectively at Stations 25A and 25B. Mean concentrations in the central portion of the inner harbour (Stations 14 and 15) were between 64 and 81 µg/g.

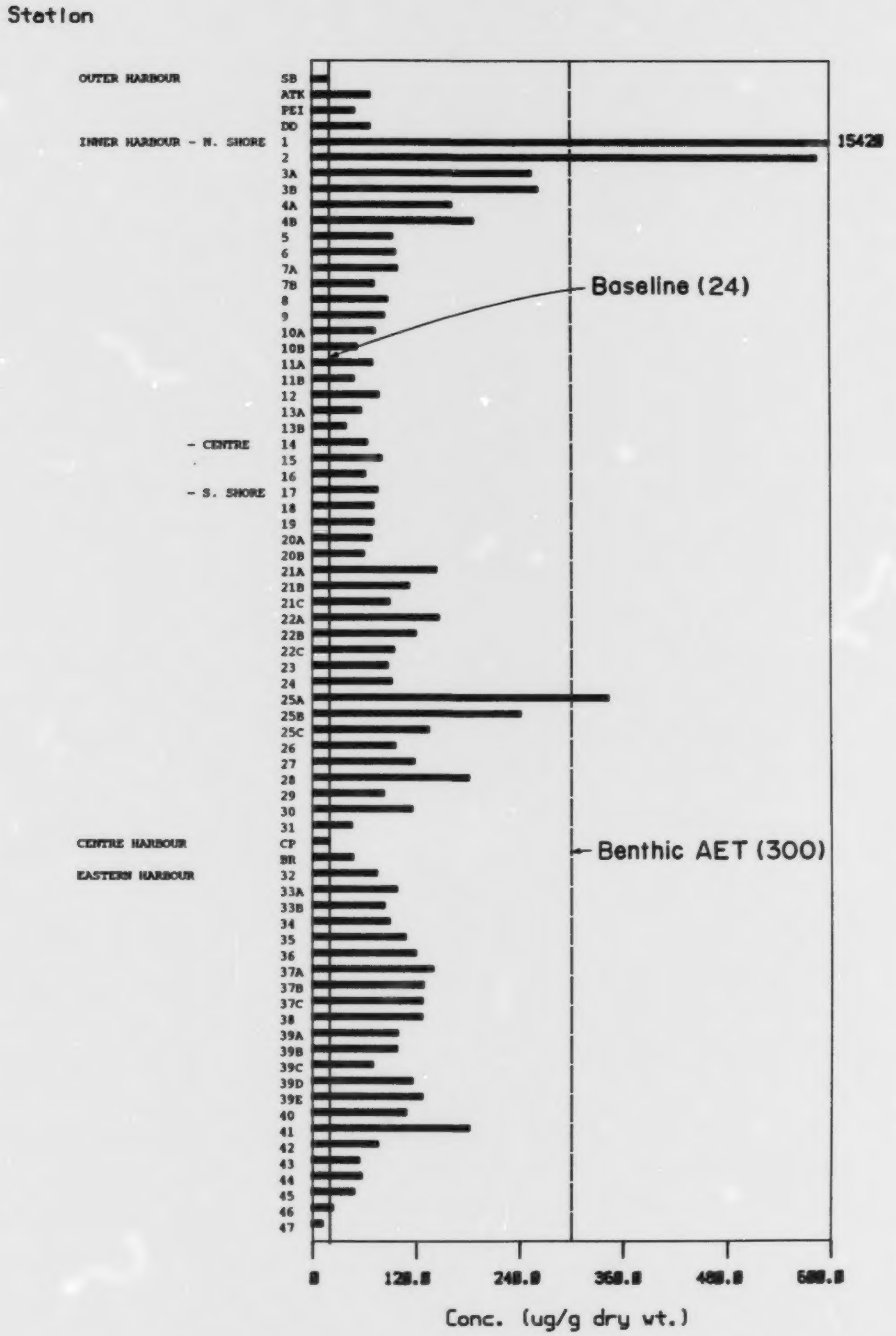


FIGURE 15 Mean Surface Sediment Lead Concentrations in Vancouver Harbour (1985-86)

Although generally lower than those found in the inner harbour, lead levels were elevated in Port Moody Arm. In 1985/86, concentrations averaged 94.4 ± 39.4 µg/g (range, 12 - 182 µg/g). In 1987, the average was 92.5 ± 43.4 µg/g (range, 19 - 298 µg/g). The distribution of surficial sediments indicated an increase towards the Ioco refinery. Maximum concentrations occurred at Station 41 (182 µg/g) in 1985/86 and Station 40 (298 µg/g) in 1987, both located near the refinery. Bourne (1974) reported lead levels in surface sediment samples from 70 stations in Port Moody Arm ranging 1.0 - 260 µg/g (mean, 70 µg/g,).

In addition, elevated levels were found in core samples taken in the middle of Port Moody Arm (Station 39C) in 1988, to a core depth of 16 cm. (Goyette, unpublished data). Concentrations in the upper 42 cm of a core taken near the entrance to the arm (Station 33B) ranged between 25 - 173 µg/g, increasing sharply to 674 µg/g at the core bottom (70 cm). Historically, there had been a source of lead near the entrance to Port Moody Arm at the Allied Chemical plant, however, periodic channel dredging in the area limits investigation. At Station 40, the pattern was reversed; lead concentrations in core samples decreased from 197 µg/g to 10 µg/g between the 16 and 20 cm, down to <8 µg/g at 80 cm.

Most areas of Vancouver Harbour (96%) exceeded the natural sediment lead levels (24 µg/g) while only 8% were above the Puget Sound BAET (300 µg/g). The three critical areas of contamination were adjacent to Vancouver Wharves, the south shore of the inner harbour near the CSO, and the north shore of Port Moody Arm near the Ioco refinery.

Lead is a restricted substance under the ocean dumping provisions of CEPA, although here are no set criteria for ocean disposal of dredge spoils containing lead. By comparison, Quebec and Ontario provincial criteria for ocean disposal specify maximum lead concentrations of 20 µg/g and 50 µg/g, respectively. (Garrett, 1985d).

4.1.1.7 Zinc. Zinc has wide industrial application due to its chemical and metallurgical properties. It is used primarily in galvinizing metals, zinc-based alloys and brass (Moore and Ramamoorthy, 1984a), but also used in paints, textile dying, printing, and making rubber.

Mean sediment zinc concentrations in Vancouver Harbour in 1985/86 ranged between 88 and 2267 µg/g. Computer estimated (SPANS) zinc distribution is shown in Figure 16. Mean concentration per station are mapped in Appendix A (Figure 9) for 1985/86 and Appendix C (Figure 11) for 1987. Zinc concentrations for Puget Sound have been reported between 19 and 4700 µg/g (Evans-Hamilton and D.R. Systems, 1987). Nearshore areas in Elliot Bay, near Seattle, were reported as 32 - 4700 µg/g; outer Elliot Bay, 21 - 830 µg/g. In the Fraser River estuary, Fanning et al. (1989) reported concentrations between 51.8 - 107 µg/g on Sturgeon Bank and Harding et al. (1988), between 57.7 - 86.0 µg/g on Roberts Bank.

Figure 17 relates average concentration at each sampling location in 1985/86 to the natural reference level (<115 µg/g) and Puget Sound BAET (260 µg/g - Tetra Tech, 1986). Natural reference levels for Vancouver Harbour are estimated to be <115 µg/g. Mean concentration at Spanish Banks in 1985/86 was 108 µg/g. In 1988, zinc concentrations in the surface sediments at this site ranged from 104 - 114 µg/g (Goyette, unpublished data). Zinc concentrations in Loughborough Inlet in 1987 averaged 120 µg/g (Appendix C). Natural sediment zinc concentrations in the Puget Sound region are reported at 100 µg/g (Evans-Hamilton and D.R. Systems, 1987). Alice Arm natural background levels range from 90 to 150 µg/g (Goyette and Christie, 1982).

In the outer harbour, zinc concentrations were from 108 - 206 µg/g. In 1985/86, the inner harbour averaged 416.8 µg/g (range, 113 - 2267 µg/g). Similar to copper and lead, zinc concentrations maximized in the vicinity of Vancouver Wharves (Stations 1 and 2). Sediment concentrations at these locations were 2267 and 654 µg/g, respectively, decreasing to 520 and 518 µg/g, respectively, in 1987. In 1980/81, Garrett found levels as high as 4650 µg/g on the shoreline adjacent to the loading docks (unpublished data). Elevated levels (519 to 1372 µg/g) extended eastward along the north shore (Stations 3 - 5) diminishing to 256 - 646 µg/g at Stations 7 to 13 near

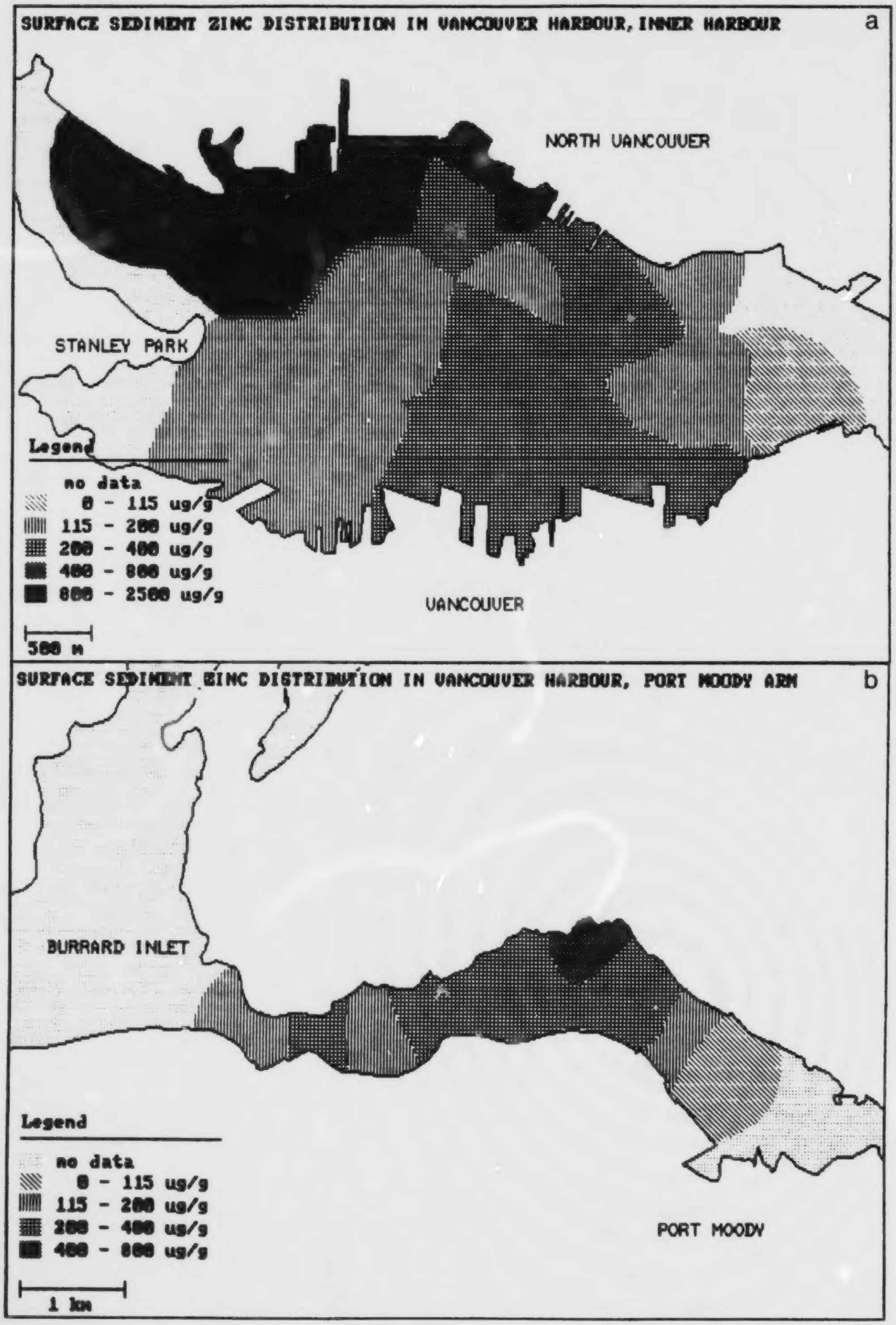

SURFACE SEDIMENT ZINC DISTRIBUTION IN VANCOUVER HARBOUR, INNER HARBOUR
a
NORTH VANCOUVER
STANLEY PARK
VANCOUVER
Legend
no data
0 - 115 ug/g
115 - 200 ug/g
200 - 400 ug/g
400 - 800 ug/g
800 - 2500 ug/g
500 m
SURFACE SEDIMENT ZINC DISTRIBUTION IN VANCOUVER HARBOUR, PORT MOODY ARM
b
BURRARD INLET
PORT MOODY
Legend
no data
0 - 115 ug/g
115 - 200 ug/g
200 - 400 ug/g
400 - 800 ug/g
1 km

FIGURE 16 SURFACE SEDIMENT ZINC DISTRIBUTION IN VANCOUVER HARBOUR (1985/86) A) INNER HARBOUR B) PORT MOODY ARM

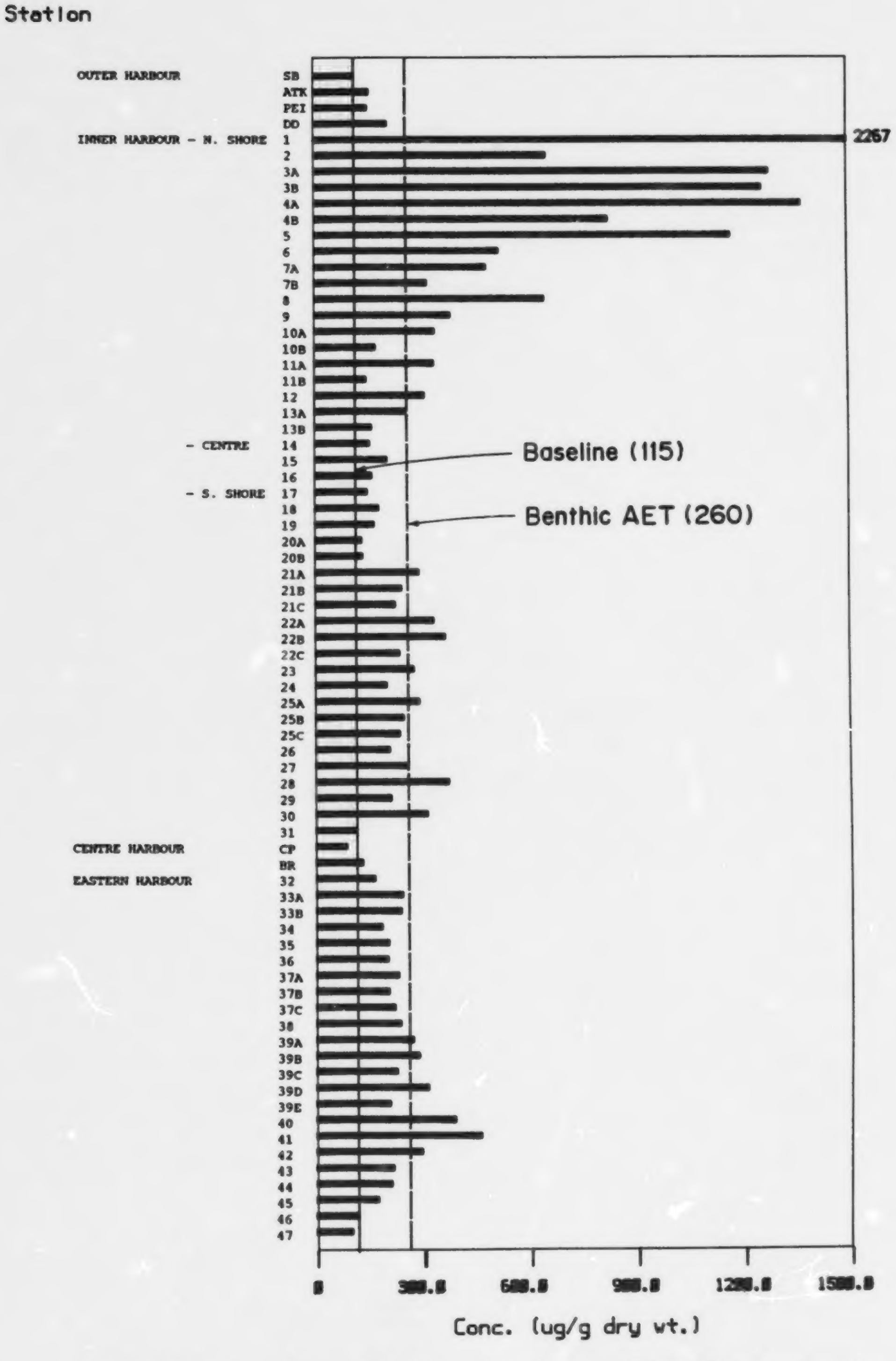


FIGURE 17 Mean Surface Sediment Zinc Concentrations in Vancouver Harbour (1985-86)

Versitile Pacific Shipyards (formerly Burrard Yarrows). In 1979, Garrett found levels between 53 and 9910 µg/g at several foreshore locations adjacent to the Burrard Yarrows site (unpublished data). In 1985/86 sources of zinc contamination were also apparent along the south shore of the inner harbour; mean concentrations ranged between 209 and 363 µg/g (16 sites) around the loading docks of the south shore between Stations 21 and 30 (Appendix A). In 1987, Stations 22A and 25A were repeated with similar results (Appendix C).

For 1985/86 and 1987, zinc levels throughout most of Port Moody Arm were slightly above the baseline level for the harbour. Mean sediment concentration in 1985/86 at 23 sites was 227.0 ± 92.2 µg/g (range, 98 - 461 µg/g); in 1987 at 32 sites, the mean was 210.1 ± 31.1 µg/g (range, 126 - 317 µg/g). Concentrations in core depths below 16 cm were <115 µg/g in 1988 (Goyette, unpublished data). Bourne (1974) reported zinc concentrations at 70 stations in Port Moody Arm ranging from 40 to 663 µg/g (mean, 152 ± 93 µg/g,).

In 1985/86, 93% of the sampling stations in Vancouver Harbour exceeded the baseline level for the harbour (115 µg/g) and 38% were above the Puget Sound BAET (260 µg/g). The stations that exceeded both were predominantly along the north shore of the inner harbour. A few bounded the south shore of the inner harbour and the Ioco refinery in Port Moody Arm. Similar to copper and lead, the major source of zinc input into the Vancouver Harbour appears to be the concentrate loading area at Vancouver Wharves due to the zinc concentrate spillage during vessel loading and unloading. The impact extends for a considerable distance along the north shore of inner harbour.

4.1.2 Surface Sediment Trace Organic Compounds

4.1.2.1 Oils and Grease and Hydrocarbons. The term "oils and grease" refers to organic compounds, such as hydrocarbons, fatty acids, soaps, fats, waxes, and oils, which are extracted by a particular solvent, Freon 113 in this case. This parameter is included since it is often used in monitoring liquid effluents. The hydrocarbon measure is a subsequent step to oils and grease qualification, differing only by the addition of silica gel to the sample. This eliminates some interferences present in the oils and grease test, such as organic dyes and sulphur compounds. However, it is a crude test, and dependent on the method of extraction, therefore, its use in identifying specific hydrocarbon sources is limited. Sulphur is present in the marine sediments off the bulk loading facilities in Port Moody Arm and on the north shore of the inner harbour.

Based on extrapolations from point data (SPANS) hydrocarbon distribution in the surface sediments of the inner harbour and Port Moody Arm (1985/86) are shown in Figure 18. Maps of mean hydrocarbon concentration for each sampling location are contained in Appendix B (Figure 3) for 1985/86 and Appendix C (Figure 12) for 1987. Refer to these appendices for oils and grease values as well.

A bar graph showing the variation in mean hydrocarbon levels per station is given in Figure 19. Existing data on the harbour is insufficient to distinguish natural from anthropogenic sediment hydrocarbons levels in the harbour. The lowest level in the harbour was 19 µg/g (Station 13A). Sediment along the north shore was slightly coarser than other regions of the harbour and may account for the lower concentration. In 1987, hydrocarbon concentrations in sediment samples from Loughborough Inlet averaged 66 µg/g) (Appendix C). Baseline levels below 70 µg/g in unpolluted sediments have been reported by Berge et al. (1987) and Law and Androlewicz (1983).

Mean concentrations in the outer harbour in 1985/86 and 1987 were between 150 and 294 µg/g. In 1985/86, levels in the inner harbour averaged 680.7 µg/g (range, 19 - 6587 µg/g). A major source of hydrocarbons to the inner harbour appears to be the combined sewer overflows located on the south shore. Maximum concentrations occurred at Station 25A, near the Clark Drive/Vernon Relief outfalls (mean, 6587 µg/g). Near the one at Victoria Drive, mean concentrations were 2310 and 1160 µg/g for Stations 29 and 30, respectively. Elevated levels (1241 - 1883 µg/g) were also observed at

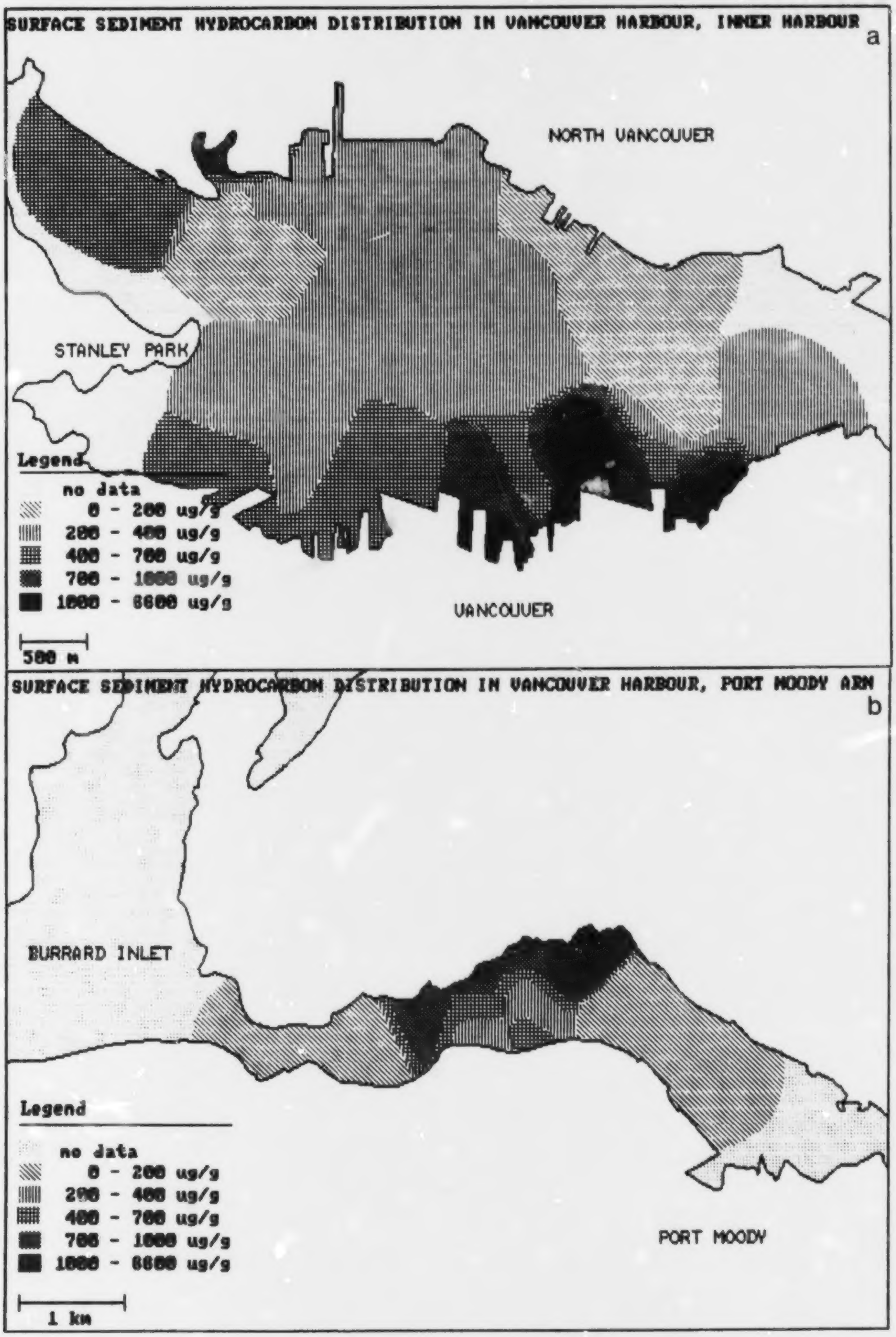

SURFACE SEDIMENT HYDROCARBON DISTRIBUTION IN VANCOUVER HARBOUR, INNER HARBOUR
a
NORTH VANCOUVER
STANLEY PARK
VANCOUVER
Legend
no data
0 - 200 ug/g
200 - 400 ug/g
400 - 700 ug/g
700 - 1000 ug/g
1000 - 6600 ug/g
500 m
SURFACE SEDIMENT HYDROCARBON DISTRIBUTION IN VANCOUVER HARBOUR, PORT MOODY ARM
b
BURRARD INLET
PORT MOODY
Legend
no data
0 - 200 ug/g
200 - 400 ug/g
400 - 700 ug/g
700 - 1000 ug/g
1000 - 6600 ug/g
1 km

FIGURE 18 SURFACE SEDIMENT HYDROCARBON DISTRIBUTION IN VANCOUVER HARBOUR (1985/86) A) INNER HARBOUR B) PORT MOODY ARM

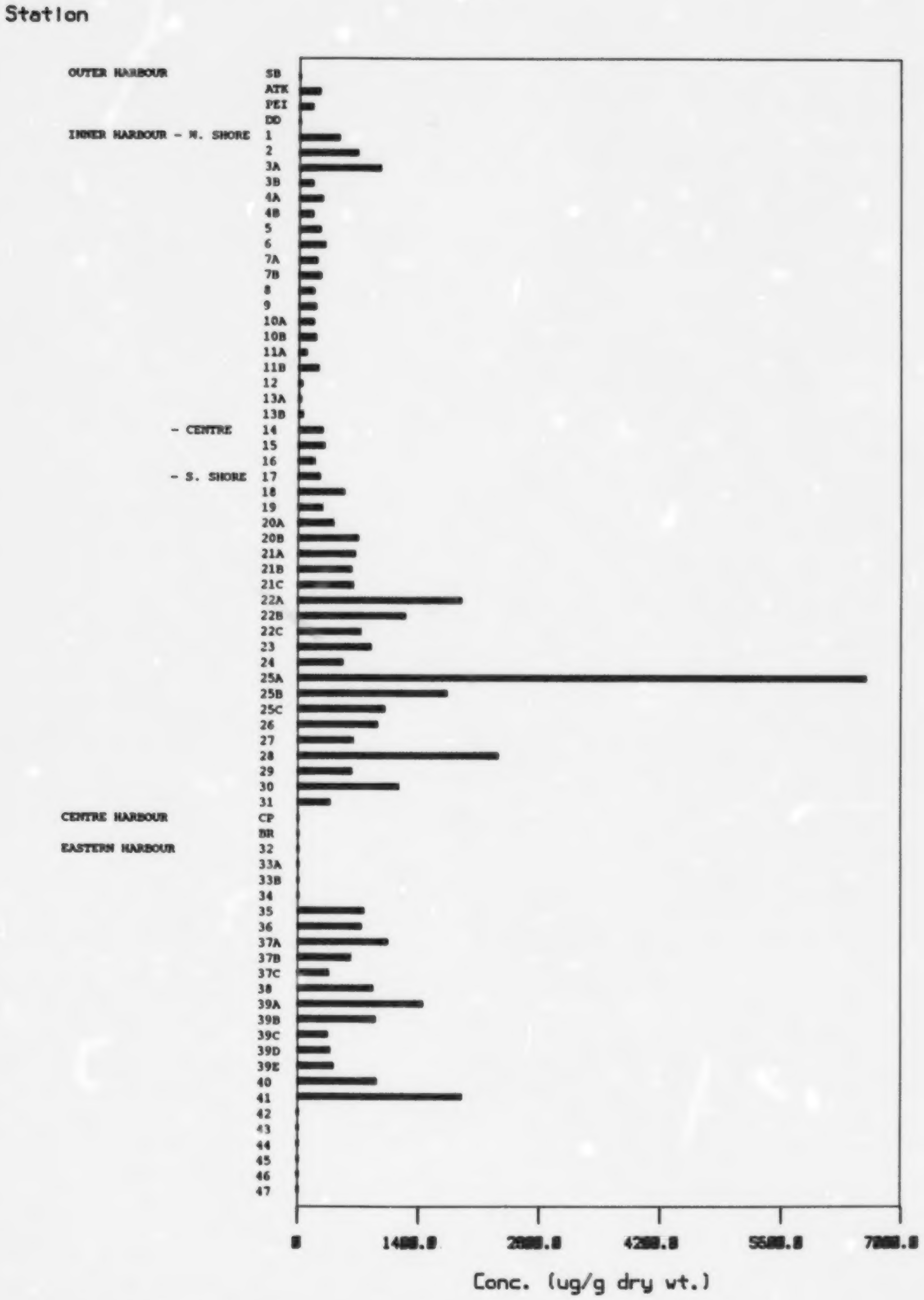


FIGURE 19 Mean Surface Sediment Hydrocarbon Concentrations in Vancouver Harbour (1985-86)

Stations 22A and 22B. In 1987, concentrations at Stations 25A and 22A decreased marginally to 4467 and 1334 µg/g, respectively. Other studies have also shown that urban stormwater runoff contributes significant hydrocarbon inputs to the receiving environment (Brown et al., 1985; Eganhouse and Kaplan, 1981; Hoffman et al., 1982).

Port Moody Arm has had a long history of petroleum refining operations dating back to 1917. Until March 1989, the Ioco refinery discharged both treated stormwater and treated process water directly into the arm. The treated process water now goes to the GVRD sewer system. Other refineries in the area discharge treated stormwater directly into Port Moody Arm. The history of petroleum refining in Port Moody Arm is reflected by the hydrocarbon concentrations throughout the arm. In 1985/86, the sediment hydrocarbon concentration averaged 813 ± 456 µg/g; the range was 729 - 1897 µg/g at 13 stations. Detailed sampling conducted in 1987 showed a broader range of 496 - 2483 µg/g (mean, 1178 ± 379 µg/g) with concentrations in the middle of Port Moody Arm consistantly above 1000 µg/g, increasing toward the Ioco refinery. Higher concentrations were also found off the Petro-Canada loading dock and Reed Point Marina. Drainage from the Petro-Canada tank farm and an abandoned landfill site represent potential sources of hydrocarbon contamination.

High hydrocarbon levels in Port Moody Arm may be partly due to the low water circulation and reduced oxygen levels in the bottom sediments. Waldichuk (1965), reported about 30% exchange on each tidal cycle. Mille et al. (1988) found rapid hydrocarbon degradation in sediment when the dissolved oxygen concentration in the overlying seawater was high and the redox potential was around +150 mV. Degradation was slower when the dissolved oxygen concentration and redox potential decreased. Under suboxic conditions (dissolved oxygen 0.2-0.3 mg/l) no degredation occurred. The black appearance of sediment from most areas of Port Moody Arm and strong odour of hydrogen sulphide indicating anoxic conditions, suggest that the hydrocarbon degradation rate would be relatively low. Degradation rates in most other parts of the harbour, would be greater because of the increased tidal flushing and resulting higher oxygen levels.

4.1.2.2 **Polycylic Aromatic Hydrocarbons**. Polycyclic aromatic hydrocarbons (PAH), are important organic contaminants in sediments from industrial and urban environments due to their toxicity and carcinogenic properties.

PAH can originate from both natural and anthropogenic sources, two prime ones being fossil fuels and incomplete combustion of organic compounds. The most significant anthropogenic source to the aquatic environment is connected with oil and industrial processes involving fossil fuels. Other urban sources include partially combusted fuels, exhaust soot, and asphalt and automobile tire wear; crude oil and petrochemical refining effluents; creosote pilings; and used motor oils. Pruell et al. (1988) found that PAH were not detected in new automotive crankcase oils but increased rapidly with usage. Carcinogenic PAH (e.g. benzo(a)pyrene) were only detected in oil used for the longest distance (about 5800 miles).

Few PAH are produced or used commercially. Napthalene is used to manufacture solvents, lubricants, and dyes (Moore and Ramamoorthy, 1984b). It is also used in moth repellant, insecticides, vermicides, and intestinal anticeptics. Acenaphthalene is used as an intermediate in dyes, plastics and pesticide synthesis. Phenanthrene is also used as an intermediate in dye manufacturing.

Earlier screening of sediment for EPA priority pollutants, at key industrial areas in Vancouver Harbour indicated that pthalate esters (catalysts used in producing plastics) and PAH were the predominant organic chemicals present. Total PAH concentrations were up to 43.2 µg/g (Garrett, unpublished data). Due to low water solubility, PAH in aquatic environments are generally associated with suspended or deposited particulate matter. According to Neff (1979), once deposited in sediments, PAH are less subject to photochemical or biological oxidation, especially if the sediment is anoxic. Hence, sedimentary PAH tend to be quite persistant and may accumulate to high concentrations. Sediments will nearly always contain concentrations of 1,000 or more than the overlying water (Neff, 1979).

The environmental significance of PAH to marine organisms is becoming increasingly apparent. Recent studies, particularly in Puget Sound (Malins et al., 1988), have shown a strong relationship between sediment associated PAH and the prevalence of preneoplastic and neoplastic liver lesions in English sole (Parophrys vetulus) and other flatfish (Malins et al., 1988; Myers et al., 1987; Mix, 1986). Impairment in ovarian development through exposure to PAH contaminated sediments has been shown in English sole from Puget Sound (Johnson et al., 1988). Payne et al. (1988) demonstrated changes in basic metabolic functions in winter flounder (Pseudopleuronectes americanus) maintained for up to four months on crude oil-contaminated sediments containing less than 1 µg/g, total PAH. The presence of PAH in sediment has therefore lead to both environmental and human health concerns.

Low molecular weight PAH (LPAH), 2-3 ring aromatics such as naphthalene, fluorene, phenanthrene, and anthracene, are generally more acutely toxic to aquatic organisms. (Neff, 1979; Moore and Ramamoorthy, 1984b). They are often associated with petroleum-derived materials (Readman et al., 1982). High molecular weight PAH (HPAH), 4-6 ring aromatics, are generally not acutely toxic but a number have proved carcinogenic (Moore and Ramamoorthy, 1984b). While sediment PAH concentration is frequently given as total PAH (TPAH), the sum of the individual compounds, the toxicological and carcinogenic effects largely depend upon the molecular weight. Toxicity using Puget Sound BAET values (Tetra Tech, 1986) is compared to relative carcinogenicity (National Academy of Science, 1972) for 20 PAH compounds in Table 5.

Mean sediment PAH concentrations in 1985/86 (24 sites) and 1987 (23 sites) are summarized by low molecular weight, high molecular weight, and total (Table 6). Sampling was concentrated in the inner harbour in 1985/86 and in Port Moody Arm in 1987. Figure 20a and 20b shows the results graphically for 1985/86 and 1987, respectively, comparing low molecular weight PAH, high molecular weight PAH and total PAH concentrations. Results are detailed in Appendix B for 1985/86 and Appendix C for 1987.

TABLE 5 COMPARISON OF PAH TOXICITY BASED ON THE BENTHIC APPARENT EFFECTS THRESHOLD (BAET) (TETRA TECH, 1986) AND RELATIVE CARCINOGENICITY (NATIONAL ACADEMY OF SCIENCE, 1972).

PAH Compounds	Puget Sound BAET (µg/g)	Relative Carcinogenicity*
Low Molecular Weight PAH (LPAH)		
naphthalene	2.1	-
acenaphthylene	.640	-
acenaphthene	.500	
fluorene	.640	-
dibenzo(a,h)fluorene	-	+/-
phenanthrene	3.20	-
anthracene	1.30	-
Total LPAH	**6.1**	
High Molecular Weight PAH (HPAH)		
fluoranthene	6.30	-
pyrene	>7.3	-
benzo(a)anthracene	4.5	+
chrysene	6.7	+/-
benzofluoranthenes	8.0	
benzo(b)fluoranthene	-	++
benzo(j)fluoranthene	-	++
benzo(k)fluoranthene	-	-
benzo(a)pyrene	6.8	+++
dibenz(a,h)pyrene	-	+++
benzo(e)pyrene	-	-
indeno(1,2,3-c,d)pyrene	>5.2	+
dibenzo(a,h)anthracene	1.2	+++
benzo(g,h,i)perylene	5.4	-
Total HPAH	**>51**	

* - not carcinogenic
+/- weakly carcinogenic or uncertain
+ carcinogenic
++, +++, strongly carcinogenic

TABLE 6 MEAN POLYCYCLIC AROMATIC HYDROCARBON (PAH) CONCENTRATIONS (µg/g DRY WEIGHT) IN VANCOUVER HARBOUR - LOW MOLECULAR WEIGHT (LPAH), HIGH MOLECULAR WEIGHT (HPAH) AND TOTAL PAH - 1985/86 AND 1987.

STATION	1985/86			1987		
	LPAH	HPAH	TOTAL PAH	LPAH	HPAH	TOTAL PAH
OUTER HARBOUR						
PEI	0.32	1.13	1.45	0.31	1.45	1.76
EB	-	-	-	0.79	3.04	3.83
INNER HARBOUR						
1	2.78	4.68	7.46	-	-	-
2	0.32	0.71	1.03	-	-	-
3A	3.42	8.82	12.24	-	-	-
3B	0.78	1.84	2.62	-	-	-
4A	1.80	5.33	7.13	-	-	-
14	0.43	1.16	1.59	-	-	-
15	0.75	1.79	2.54	0.59	1.82	2.41
16	1.34	3.58	4.92	0.83	2.70	3.53
17	1.43	4.25	5.68	-	-	-
19	1.55	5.49	7.04	1.10	3.59	4.69
21	2.21	2.01	4.22	-	-	-
22A	7.51	6.60	14.11	2.29	9.93	12.22
23	2.58	2.65	5.23	-	-	-
24	1.39	1.50	2.89	-	-	-
25A	2.57	2.40	4.97	3.39	14.03	17.42
28	1.37	3.50	4.87	-	-	-
30	3.73	5.80	9.53	-	-	-
PORT MOODY ARM						
33B	-	-	-	1.13	3.28	4.41
35	0.71	2.23	2.94	-	-	-
36A	-	-	-	1.07	2.97	4.04
36B	-	-	-	1.14	4.22	5.36
36C	-	-	-	5.64	11.55	17.19
37A	-	-	-	1.53	5.78	7.31
39A	-	-	-	1.80	6.77	8.57
39C	1.02	2.46	3.48	1.60	4.48	6.08
39D	1.31	2.55	3.86	-	-	-
39E	0.88	2.34	3.22	4.76	31.97	36.73
40	1.84	3.09	4.93	2.96	18.82	21.78
41A	1.15	3.68	4.83	1.45	6.58	8.03
41B	-	-	-	1.19	5.34	6.53
41D	-	-	-	1.50	4.05	5.55
42A	-	-	-	1.63	3.23	4.86
42B	-	-	-	1.14	3.88	5.02
42C	-	-	-	1.09	3.57	4.66
47A	-	-	-	1.06	3.40	4.46

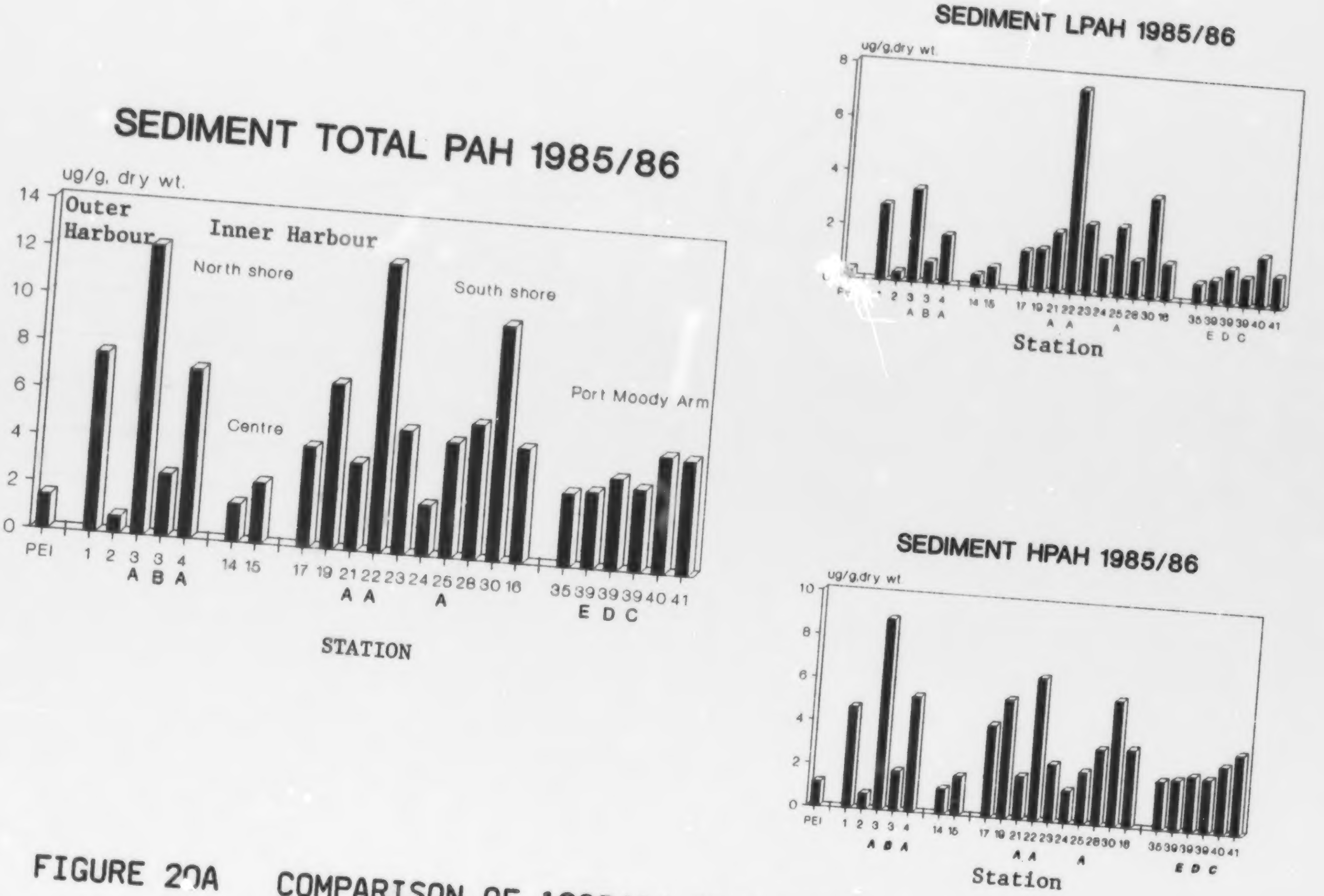


FIGURE 20A COMPARISON OF 1985/86 SEDIMENT PAH CONCENTRATIONS (UG/G DRY WEIGHT) IN VANCOUVER HARBOUR - LOW MOLECULAR WEIGHT, HIGH MOLECULAR WEIGHT AND TOTAL

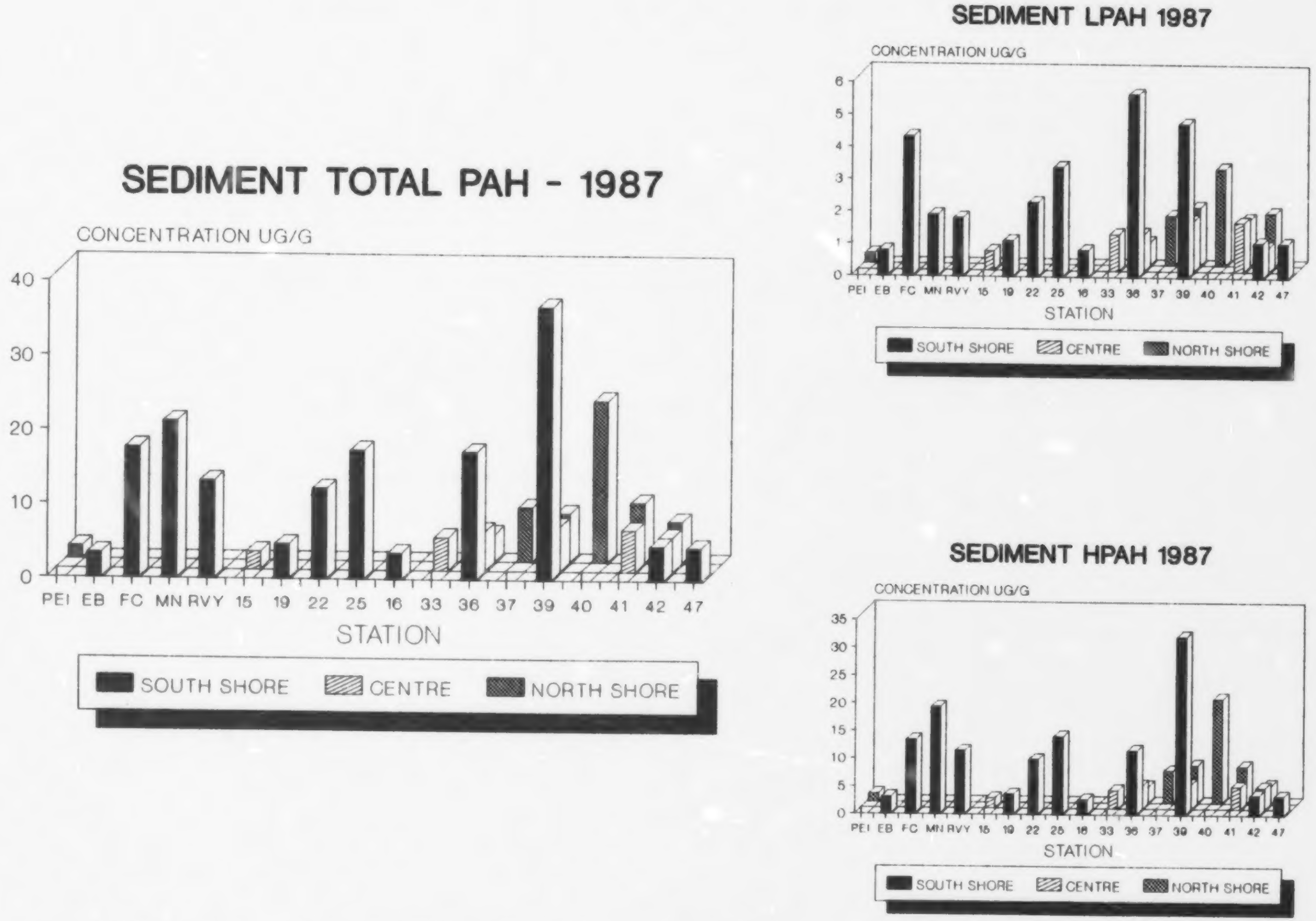


FIGURE 20B COMPARISON OF 1987 SEDIMENT PAH CONCENTRATIONS (UG/G DRY WEIGHT) IN VANCOUVER HARBOUR - LOW MOLECULAR WEIGHT, HIGH MOLECULAR WEIGHT AND TOTAL

Existing data on sediment PAH concentrations in Vancouver Harbour are insufficient to estimate a baseline level. Fanning et al. (1989), however, found that total PAH concentrations in the Fraser River estuary were all below the detection limits of 0.04 - 0.12 µg/g. Reference levels given for LPAH and HPAH in Puget Sound were 0.056 µg/g and 0.058 µg/g, respectively (Evans-Hamilton and D.R. Systems, 1987). In the outer harbour (Station PEI), total PAH concentrations, in 1985/86 and 1987 were 1.45 µg/g (LPAH = 0.32 µg/g; HPAH = 1.13 µg/g) and 1.76 µg/g (LPAH = 0.31 µg/g; HPAH = 1.45 µg/g), respectively. However, this station would still likely be under the influence of some anthropogenic sources, either locally or from within the inner harbour, or possibly both.

Total PAH concentrations for the inner harbour in 1985/86 ranged from 1.03 µg/g (Station 2) to 14.11 µg/g (Station 22A). The latter concentration was partly due to particularly high napthalene levels not observed at other sampling locations. In 1987, maximum concentrations in the inner harbour (17.42 µg/g) occurred off the combined sewer overflows at Station 25A. Concentrations of benzo(a)pyrene, a known carcinogen (Table 5), ranged from 0.73 - 1.6 µg/g. Sediment samples from the east basin of False Creek (FC), English Bay (EB), near the entrance to False Creek and Coal Harbour (MN & RYC) were recently analyzed for PAH (Goyette, unpublished data). These results have been included in Figure 21 for comparison. In 1988, total PAH concentration in False Creek east basin was 17.2 µg/g (LPAH = 4.3 µg/g; HPAH = 12.9 µg/g). Concentrations up to 331.6 µg/g have been reported previously in the same area (Greater Vancouver Regional District, 1987). In English Bay, near the entrance to False Creek, total PAH concentration was 3.38 µg/g (LPAH = 0.70 µg/g; HPAH = 3.04 µg/g). Levels at two locations in Coal Harbour, Menchions shipyard (MN) and the Royal Vancouver Yacht Club (RVY), were 21.2 µg/g (LPAH = 1.9 µg/g: HPAH = 19.3 µg/g) and 13.2 µg/g (LPAH = 1.8 µg/g; HPAH = 11.4 µg/g), respectively.

The major PAH compounds found in surface sediments from the harbour were phenanthrene in the low molecular weight range and fluoranthene, pyrene, chrysene, benzo(k)fluoranthene, and benzo(b)fluoranthene in the high molecular weight range. Carcinogenic compounds including benzo(a)pyrene and indeno(1,2,3-cd)pyrene were also present. The HPAH, the more carcinogenic fraction, represented the largest PAH fraction in most samples (0.71 - 8.82 µg/g). Total PAH concentrations in the offshore areas of the inner harbour (Stations 14 and 15) were 1.59 and 2.54 µg/g, respectively. In Port Moody Arm (1985/86), concentrations ranged from 2.94 µg/g, near the entrance to Port Moody Arm (Station 35) to 4.93 µg/g, off the Ioco refinery (Station 40). In 1987, total PAH concentrations in Port Moody Arm ranged fom 4.04 µg/g (Station 36A) to 36.73 µg/g (Station 39E). Benzo(a)pyrene concentrations in two samples from Station 39E were 1.9 and 3.0 µg/g. In 1988, PAH were found in core samples down to the bottom core depths of 12 cm at Stations 33B (TPAH = 3.1 µg/g) and 16 cm at Station 40 (TPAH = 5.7 µg/g) (Goyette, 1988, unpublished data).

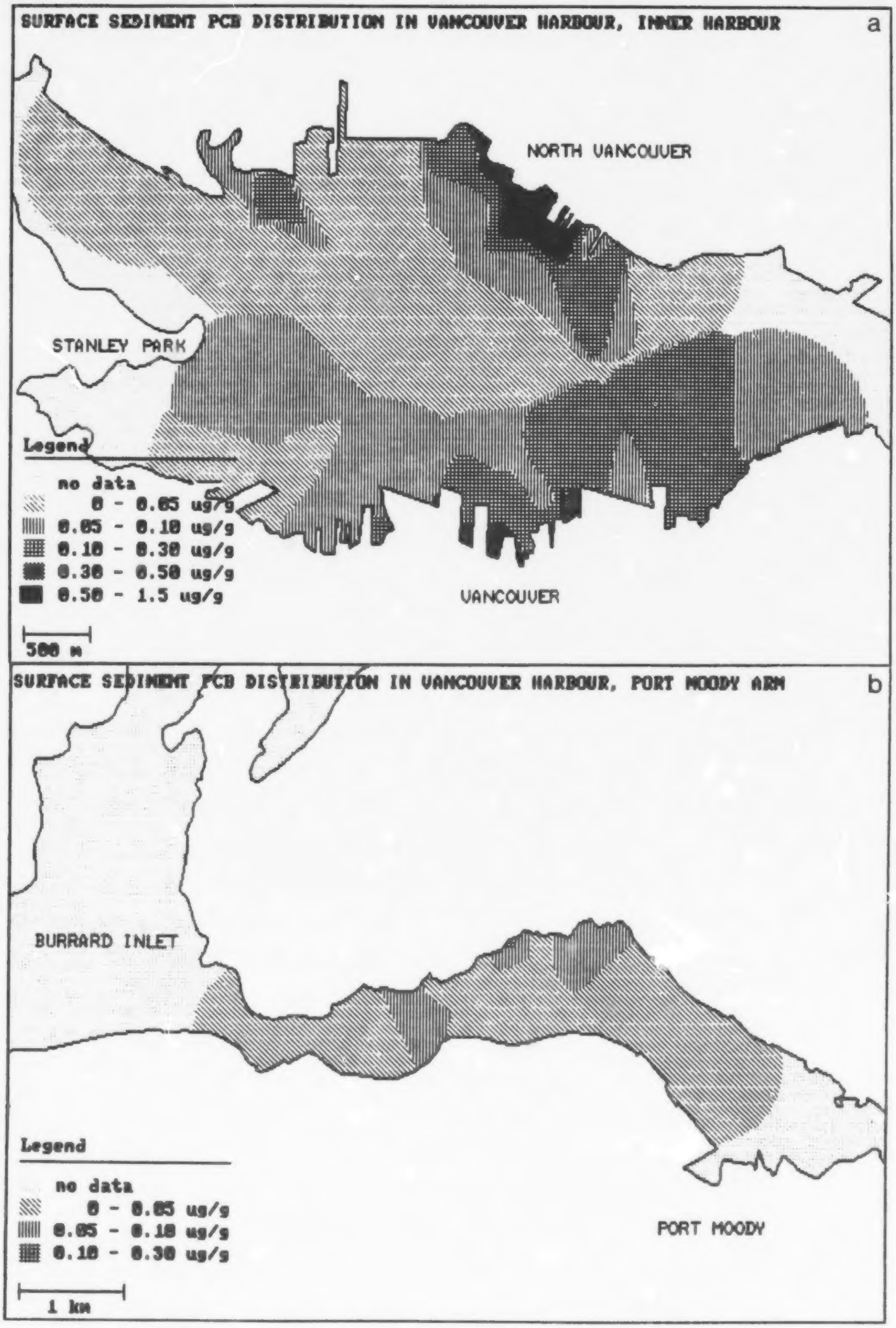
Sediment PAH concentrations reported for the Fraser River estuary are considerably lower than those found in Vancouver Harbour. Near the Iona sewage treatment plant outfall, total PAH concentrations were all below detection (<.10 µg/g), (Fanning et al. 1989). Harding et al. (1988) reported low levels (0.166 - 0.177 µg/g) in the same area. PAH concentrations in samples from Roberts Bank and Sturgeon Bank were below 0.10 µg/g (Harding et al. 1988). PAH concentrations in Sidney Harbour, Nova Scotia were reported between 0.0029 and 310 µg/g, total PAH (Kieley et al., 1988), the latter near the Sidney Steel Company Tar Ponds. In the Puget Sound area, HPAH varied over four orders of magnitude (Evans-Hamilton and D.R. Systems, 1987); maximum concentrations occurring in urban embayments. Levels near sewer trunk outfall were reported at 8.1 - 258 µg/g; off a coal-tar processing plant in Eagle Harbour, 10.4 - 63.9 µg/g; and at nearshore areas in Elliot Bay (Seattle), 0.210 - 134 µg/g. Evans-Hamilton and D.R. Systems (1987) indicate that there were more areas of concern in Puget Sound for HPAH than any other parameter.

The chief sources of PAH input to the Vancouver Harbour appear to be the combined sewer overflows at Station 25A, the Ioco refinery and sources near the Petro-Canada loading docks and Reed Point Marina. Unidentified sources occur near Stations 22A and 3A. No sampling stations exceeded the Puget Sound BAET value (6.6 µg/g) for LPAH, nor the BAET for

HPAH (>51 µg/g) (Table 5). However, the Puget Sound BAET values are based primarily on acute toxicity and do not necessarily address chronic effects such as the pathological changes which have been linked with exposure to PAH (see Section 4.2.4.3). An interim screening limit of 2.5 µg/g, total PAH has been proposed under the Canadian Environmental Protection Act for dredge spoils intended for ocean disposal. Additional provisions state that above this level toxicological tests are required, and material containing carcinogenic compounds (i.e. HPAH) should not be be placed on critical habitats.

4.1.2.3 **Polychlorinated Biphenyls**. Polychlorinated Biphenyls (PCB) have been used extensively to produce plastics, inks, paints, pesticides, in addition to dielectric, hydraulic high temperature lubricating and heat transfer fluids. The latter represented the greatest use in British Columbia (Garrett, 1985c). Due to widespread concern over the persistance, bioaccumulation, and biomagnification, PCB production ceased and severe restrictions were imposed on their use in the mid-1970's. In 1976, surveys of sewage treatment plants in British Columbia revealed low PCB levels in all discharges (Garrett, 1985c). Like many contaminants, PCB can accumulate in the sediment and persist for many years. Harbour areas in particular can contain high PCB levels. In Baltimore Harbour, levels were between 1.0 - 2.0 µg/g at most locations: one sample was 84 µg/g (Garrett, 1985c). In Puget Sound, the maximum PCB concentration (21.6 µg/g) was found in the Duwamish Waterway (Evans-Hamilton and D.R. Systems, 1987). Nearshore areas in Elliott Bay, near Seattle, averaged 0.75 µg/g (range, 0.002 - 13.5 µg/g). Concentrations in Commencement Bay were reported as 5.2 µg/g. Reference level for PCB in Puget Sound is given as 0.020 µg/g (Evans-Hamilton and D.R. Systems, 1987).

Concentrations for Vancouver Harbour in 1985/86, ranged from <0.02 µg/g to 0.90 µg/g. Computer estimated (SPANS) PCB sediment distribution is shown in Figure 21. Mean PCB concentrations for each station are illustrated in Figure 22. Detailed results from sediment samples collected in 1985/86 and 1987 are given in Appendix B and C, respectively. By comparison, PCB concentrations in Loughborough Inlet (1987) averaged 0.04



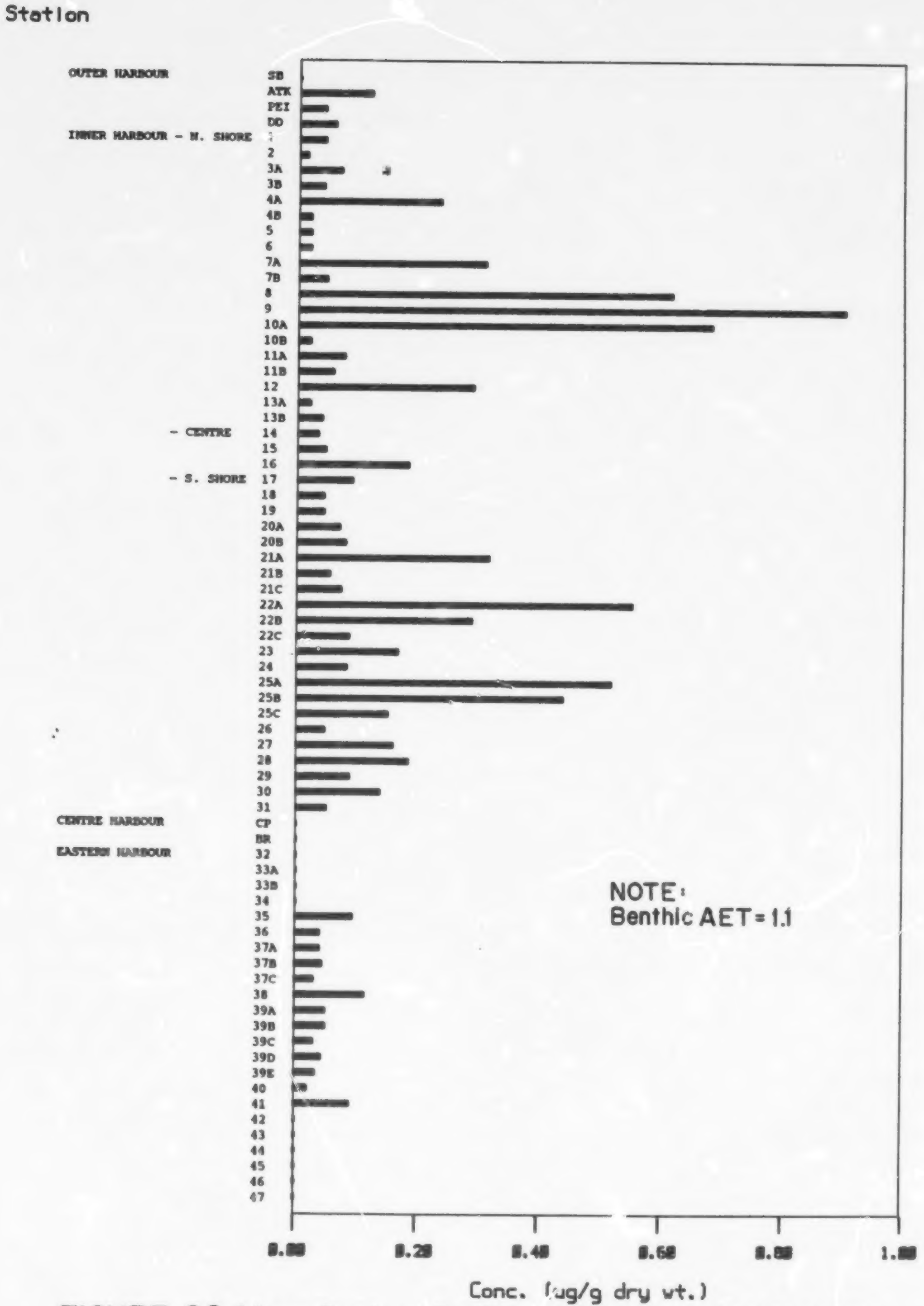
SURFACE SEDIMENT PCB DISTRIBUTION IN VANCOUVER HARBOUR, INNER HARBOUR

a
NORTH VANCOUVER
STANLEY PARK
VANCOUVER
Legend
no data
0 - 0.05 ug/g
0.05 - 0.10 ug/g
0.10 - 0.30 ug/g
0.30 - 0.50 ug/g
0.50 - 1.5 ug/g
500 m

SURFACE SEDIMENT PCB DISTRIBUTION IN VANCOUVER HARBOUR, PORT MOODY ARM

b
BURRARD INLET
PORT MOODY
Legend
no data
0 - 0.05 ug/g
0.05 - 0.10 ug/g
0.10 - 0.30 ug/g
1 km

FIGURE 21 SURFACE SEDIMENT PCB DISTRIBUTION IN VANCOUVER HARBOUR (1985/86) A) INNER HARBOUR B) PORT MOODY ARM



NOTE:
Benthic AET = 1.1

FIGURE 22 Mean Surface Sediment Polychlorinated Biphenyl (PCB) Concentrations in Vancouver Harbour (1985-86)

µg/g (range, 0.02 - 0.05 µg/g) (Appendix C). In the Fraser River estuary near Iona, PCB concentrations were <0.10 µg/g (Fanning et al. 1989). Harding et al. (1988) reported PCB concentrations at Iona, Sturgeon Bank, Fraser River Main Arm, and Roberts Bank at <0.02 µg/g.

From earlier sediment samples taken in 1981-83 Vancouver Harbour by Environmental Protection, PCB were found along the shore near shipbuilding and ship repair facilities. Garrett (1985c) reported up to 16.8 µg/g in sediment from the Coal Harbour area. In general, PCB levels found in the present study were considerably lower than foreshore samples reported by Garrett (1985). Nearshore stations along the north shore of the inner harbour (Stations 4A, 7A, 8, 9, and 10A) and the south shore (Stations 21A, 22A, 22B, 25A, 25B, 27 and 30) showed slightly higher concentrations (>0.1 µg/g) but most other areas were <0.05 µg/g. Overall mean level for the inner harbour (44 sites) was 0.17 ± 0.20 µg/g. Sediment PCB concentrations in Port Moody Arm in 1985/86 (13 sites) averaged 0.06 µg/g (range, 0.02 - 0.18 µg/g), in 1987 (32 sites) the average was 0.13 µg/g (range, 0.03 to 0.32 µg/g).

All 1985/85 and 1987 stations sampled in Vancouver Harbour were below the Puget Sound BAET (1.1 µg/g) given by Tetra Tech (1986) for PCB. The AET method, however, does not consider the bioaccumulative properties of this class of compounds, which are major environmental concerns. Under the CEPA ocean dumping provisions, PCB is a Schedule I substance and concentrations in ocean disposed materials must not exceed "0.01 parts of the concentration shown to be toxic to marine animal and plant sensitive organisms in a bioassay sample" (Garrett, 1985c). Generally, sediment containing more than 0.1 µg/g PCB are not eligible for ocean disposal. Twenty out of sixty harbour sites (primarily nearshore) in 1985/86 exceeded this limit.

4.1.2.4 **Chlorophenols**. Chlorinated phenols (chlorophenols) commonly originate from industries using chlorination process (Moore and Ramamoorthy, 1984b). Industries such as pulp mills and wood protection plants, and other chemical plants have relatively high residues in the effluents.

Chlorination of domestic sewage is another possible source. Chlorophenols are also used for their fungicidal and bactericidal properties. Pentachlorophenol and tetrachlorophenol are used mainly in wood protection (Garrett and Shrimpton, 1988).

Sediment chlorophenol concentrations were generally low throughout the harbour. Pentachlorophenol (PCP) levels in 1985/86 ranged from 0.001 - 0.135 µg/g; tetrachlorophenol (T_4CP) from 0.001 - 0.079 µg/g; and trichlorophenol between <.0003 and 0.0245 µg/g. In 1987, PCP concentrations, in samples taken primarily in Port Moody Arm, ranged from <0.0001 µg/g to 0.0019 µg/g. PCP levels found in samples from Loughborough Inlet in 1987 were all <0.0001 µg/g (Appendix C). The sediment PCP distribution pattern for the inner harbour and Port Moody Arm is shown in Figure 23. Detailed results are given in Appendix B for 1985/86 and in Appendix C, for 1987.

The sampling program did not specifically address areas of the harbour that would be directly affected by chlorophenol contamination. The most probable source would be stormwater releases from treated lumber storage yards. Studies in 1986 and 1987 by Environment Canada (Krahn et al. 1987) found up to 66 mg/l total chlorophenols was found in the runoff from lumber dip-treating facilaities. Bioassay tests on stormwater discharges from lumber storage yards produced rainbow trout mortalities within 40 to 120 minutes. Sediments off the two main lumber storage terminals in Vancouver Harbour, located on the north shore near Second Narrows, were not sampled in the present study.

Garrett and Shrimpton (1988) have reported sediment concentrations from areas in southern British Columbia, including Vancouver Harbour. Between 1983 and 1985, PCP and T_4CP levels were low (<0.015 µg/g) at most sites. Maximum levels detected were 0.078 µg/g T_4CP and 0.216 µg/g respectively. In 1985, sediment samples taken near the Iona sewage discharge contained maximum levels of 0.01 µg/g PCP and 0.013 µg/g T_4CP. Reference samples were ≤0.001 µg/g for both compounds. Once heavily industrialized, False Creek contained relatively low levels of chlorophenols (0.089 ug/g PCP, 0.07 µg/g T_4CP), near a former wood treatment facility.

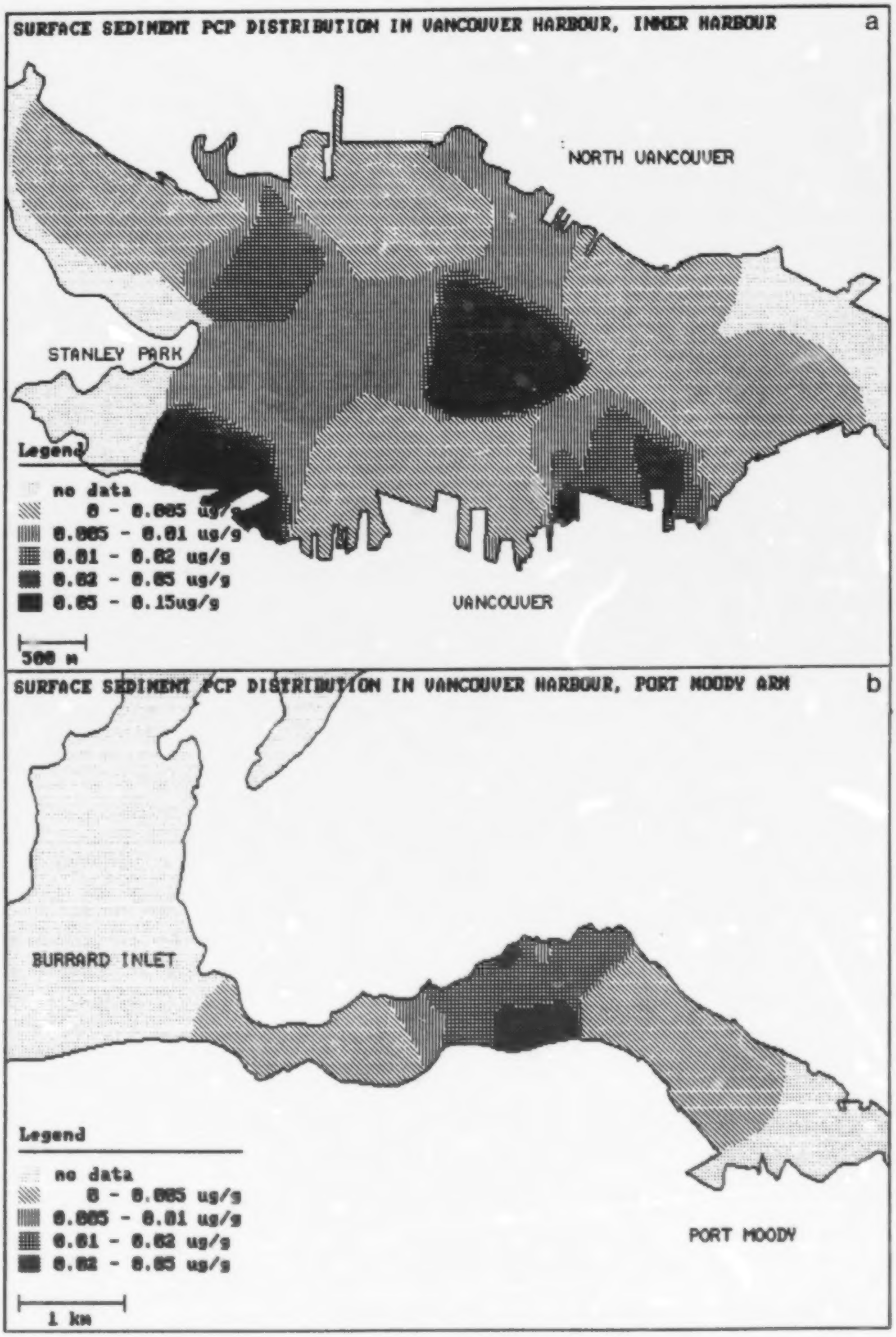

SURFACE SEDIMENT PCP DISTRIBUTION IN VANCOUVER HARBOUR, INNER HARBOUR
a
NORTH VANCOUVER
STANLEY PARK
VANCOUVER
Legend
no data
0 - 0.005 ug/g
0.005 - 0.01 ug/g
0.01 - 0.02 ug/g
0.02 - 0.05 ug/g
0.05 - 0.15ug/g
500 m
SURFACE SEDIMENT PCP DISTRIBUTION IN VANCOUVER HARBOUR, PORT MOODY ARM
b
BURRARD INLET
PORT MOODY
Legend
no data
0 - 0.005 ug/g
0.005 - 0.01 ug/g
0.01 - 0.02 ug/g
0.02 - 0.05 ug/g
1 km

FIGURE 23 SURFACE SEDIMENT PCP DISTRIBUTION IN VANCOUVER HARBOUR (1985/86) A) INNER HARBOUR B) PORT MOODY ARM

Puget Sound BAET level for PCP is >11 µg/g (Tetra Tech, 1986), well above concentrations found in Vancouver Harbour. Chlorophenols are controlled under the ocean dumping provisions of CEPA. In the Pacific and Yukon Region, a guideline of 1.0 µg/g is used as an acceptable criteria for ocean disposal (Garrett and Shrimpton, 1988). Because of their relatively high water solubility, concern over chlorophenols is primarily with the levels in water, rather than sediment.

4.1.2.5 **Organotins**. Tributlytin is highly toxic and moderately persistant in water and sediment (Maguire et al., 1985). It is usually found in areas of heavy boating and shipping traffic, consistant with its use as an antifouling agent. From 1982 and 1985, water and sediment samples were collected for organotin analysis from 265 locations across Canada which included 36 sites in Vancouver Harbour (Maguire et al., 1985). Twelve had high tributyltin concentrations which exceeded other sampling sites across Canada (1.50 µg/g - 10.78 µg/g). These sites were primarily near shipyard facilities in the inner harbour. The other sites ranged from 0.02 - 0.57 µg/g.

4.1.3 Surface Sediment Characteristics

Surface sediment characteristics were determined by visual observations, particle size distribution, and residue content (volatile and fixed residue). Particle size distribution measured the sediment texture (Table 7); residue analysis estimated organic carbon content (Figure 24). Fine grained sediments, rich in organic matter, generally have higher contaminant levels because of increased surface area and adsorptive characteristics. Detailed results are provided in Appendix D.

Sediment in the outer harbour was predominantly fine light brown silt, indicative of that from the Fraser River. Surface sediment at the Dundarave Station consisted of fine mud. The texture became coarser (sand and gravel) toward the First Narrows, making sediment grabs difficult to obtain. Along on the north shore of the inner harbour (Stations 1 to 3B) bottom sediments consisted largely of fine, black mud. Samples at Stations

TABLE 7 SEDIMENT PARTICLE SIZE DISTRIBUTION IN VANCOUVER HARBOUR (1985 - 1986)

Station	Median Particle Size	silt and clay (%)	very fine sand (%)	fine sand (%)	medium sand (%)	coarse sand (%)	very coarse sand (%)	granules (%)
SB	silt and clay	61	11	11	11	4	2	0
PEI-M85	silt and clay	51	9	12	13	8	6	1
-085	silt and clay	71	11	15	3	0	0	0
-J86	silt and clay	57	8	10	16	9	0	0
-M86	silt and clay	76	5	6	9	4	trace	0
-S86	silt and clay	84	3	3	2	2	2	4
DD	coarse sand	16	4	12	15	13	9	31
1	fine sand	15	11	37	25	5	2	5
2	medium sand	8	6	30	31	13	6	6
3A	medium sand	24	8	10	11	7	8	32
4A	fine sand	13	15	51	13	5	2	1
5	silt and clay	50	14	7	7	8	6	8
6	very fine sand	38	23	15	9	8	4	3
7A	very fine sand	36	21	13	14	11	5	trace
7B	very fine sand	34	20	11	10	9	9	7
8	very fine sand	31	31	18	10	7	3	trace
9	very fine sand	37	23	15	9	7	4	5
10A	fine sand	20	22	22	16	13	6	1
10B	fine sand	29	20	25	12	9	4	1
11A	fine sand	18	26	29	9	5	3	10
11B-M85	fine sand	5	13	70	7	2	2	1
-085	fine sand	3	8	69	17	1	1	1
-J86	fine sand	18	24	39	11	4	1	3
-M86	very fine sand	28	24	35	6	3	2	2
-S86	fine sand	18	20	49	7	2	2	2
12	fine sand	22	15	30	20	7	3	3
13A	medium sand	8	7	31	29	12	7	6
13B	fine sand	7	8	61	20	2	2	2
14	fine sand	26	23	22	10	5	3	11
15-J86	fine sand	28	21	14	14	14	2	7
-M86	very fine sand	38	32	19	6	3	1	1

TABLE 7 SEDIMENT PARTICLE SIZE DISTRIBUTION IN VANCOUVER HARBOUR (1985 - 1986)

Station	Median Particle Size	silt and clay (%)	very fine sand (%)	fine sand (%)	medium sand (%)	coarse sand (%)	very coarse sand (%)	granules (%)
16-M85	fine sand	5	13	70	7	2	2	1
-085	very fine sand	31	32	25	9	1	trace	2
-M86	very fine sand	36	31	21	6	4	1	1
-S86	very fine sand	26	32	29	7	4	1	1
17	very fine sand	43	30	15	6	2	1	3
18	fine sand	25	18	25	20	10	1	1
19-M85	silt and clay	61	13	9	8	6	2	1
-085	very fine sand	33	27	21	14	3	1	1
-J86	very fine sand	28	24	21	16	7	1	3
-M86	very fine sand	47	28	11	8	4	1	1
20A	silt and clay	84	5	3	4	3	1	trace
20B	very fine sand	42	22	18	8	6	2	2
21A	medium sand	15	7	19	22	8	6	23
21B	medium sand	16	11	31	31	7	2	2
21C	fine sand	25	12	20	26	10	4	3
22A	silt and clay	55	21	13	6	4	1	trace
22B	very fine sand	39	21	19	11	5	2	3
22C	very fine sand	40	16	13	11	9	8	3
23	fine sand	29	20	27	13	6	2	3
24	coarse sand	13	7	10	13	10	10	37
25A	fine sand	20	16	30	16	9	6	3
25B	fine sand	16	28	29	13	8	3	3
25C	medium sand	21	13	15	9	8	8	26
26	very fine sand	29	30	21	10	6	3	1
27	medium sand	26	11	12	17	15	9	10
28	medium sand	18	16	15	16	11	4	20
29	fine sand	25	24	19	14	7	4	7
30	very fine sand	29	32	21	7	4	2	5
31	fine sand	9	13	32	11	5	7	23
CP	fine sand	2	7	45	13	15	14	4
BR	very fine sand	38	34	15	7	5	1	trace

TABLE 7 SEDIMENT PARTICLE SIZE DISTRIBUTION IN VANCOUVER HARBOUR (1985 - 1986)

Station	Median Particle Size	silt and clay (%)	very fine sand (%)	fine sand (%)	medium sand (%)	coarse sand (%)	very coarse sand (%)	granules (%)
32	fine sand	40	8	8	14	15	14	1
33A	fine sand	31	11	12	13	16	12	5
33B	very fine sand	41	11	10	13	13	9	3
34	medium sand	34	6	8	15	18	18	1
35 -M85	medium sand	31	6	10	13	15	20	5
-O85	very fine sand	49	8	10	12	9	6	6
-J86	medium sand	30	9	11	21	21	6	2
-M86	fine sand	40	6	8	13	14	13	6
36	medium sand	37	4	6	10	10	14	19
37A	fine sand	42	5	5	7	10	15	16
37B	medium sand	33	6	7	12	15	20	7
37C	medium sand	31	8	10	14	15	15	7
38 -J86	medium sand	27	7	11	19	22	13	1
-M86	fine sand	43	5	8	12	14	12	6
39A	coarse sand	20	5	6	9	12	19	29
39B	coarse sand	30	5	6	9	12	20	18
39C	coarse sand	25	5	7	12	16	22	13
39D	fine sand	42	5	7	7	14	14	7
39E	coarse sand	25	6	7	12	15	20	15
40	coarse sand	26	4	7	11	15	19	18
41	very coarse sand	19	4	6	11	9	14	37
43	very coarse sand	26	5	6	12	18	24	9
44	coarse sand	25	4	8	12	17	25	9
45	medium sand	37	5	7	11	13	18	9
46	medium sand	30	6	10	12	14	23	5
47	fine sand	37	7	10	10	9	15	12

silt and clay = <0.063 mm
very fine sand = 0.063-0.125 mm
fine sand = 0.125-0.25 mm
medium sand = 0.25-0.50 mm
coarse sand = 0.50-1.00 mm
very coarse sand = 1.00-2.00 mm
granules = >2.00 mm

SB = Spanish Banks
DD = Dundarave
CP = Cates Park
BR = Boulder Rock

M85 = MAY 1985
O85 = OCTOBER 1985
J86 = JANUARY 1986
M86 = MAY 1986
S86 = SEPTEMBER 1986

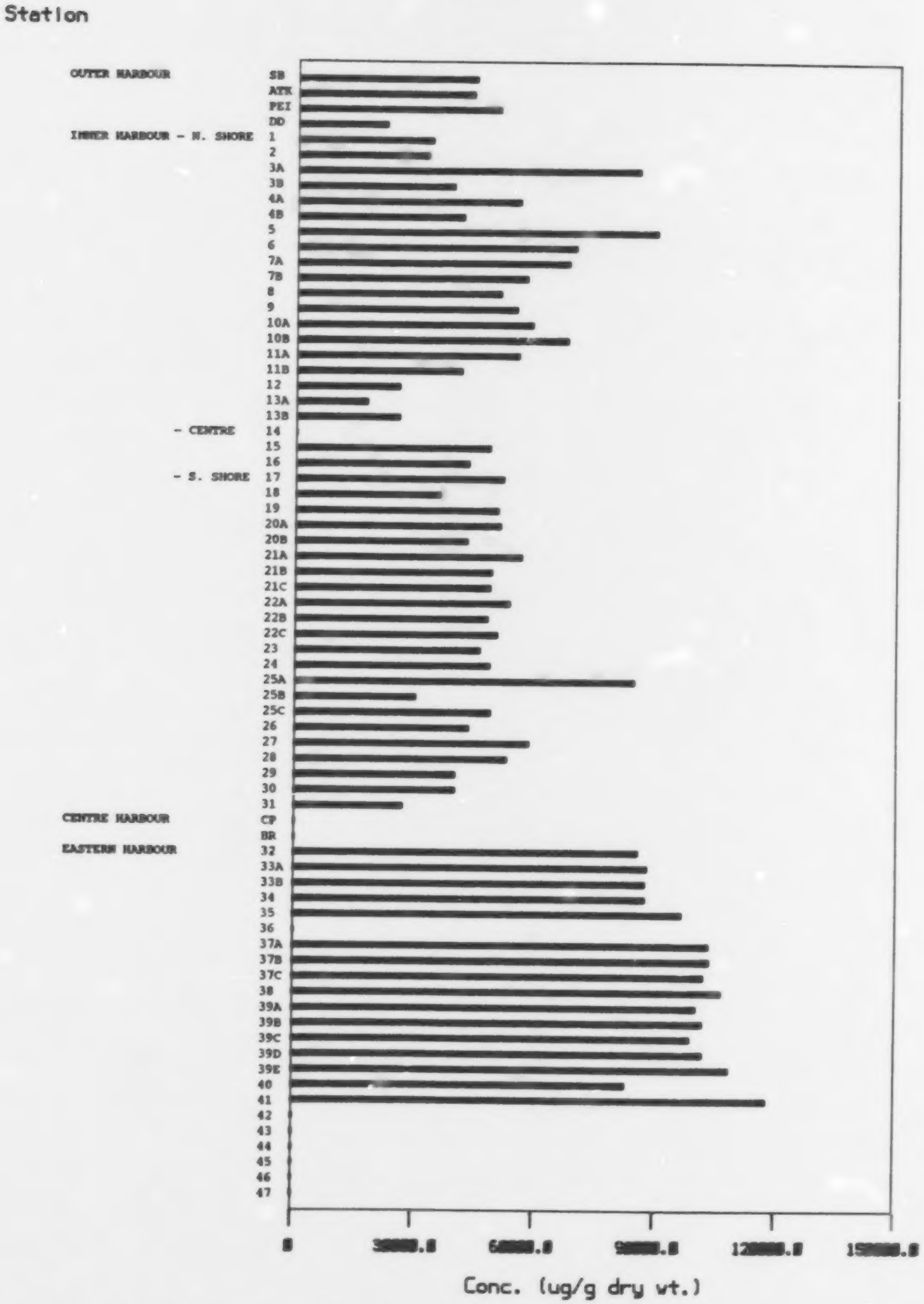


FIGURE 24 Mean Surface Sediment Volatile Residue (SVR) in Vancouver Harbour (1985-86)

3A and 3B were also fine in texture, with a strong odour of H_2S and lumps of blackened sulphur. Near stations 1 and 2, the bottom sediments were largely of sand, gravel and small rocks. This is likely due to scouring by strong tidal currents through First Narrows. Wood chips dominated samples from Station 4A and 4B, located off the Fibreco chip loading facilities. Stations 10 to 13 along the north shore consisted of fine to coarse sand, wood and shell debris, again likely due to the tidal action.

Along the south shore, sediment consisted of silt and clay at the entrance to Coal Harbour (Station 17 - 20) and fine sand along deepsea docks further east (Stations 21 - 30). Slightly coarser material was usually present near the outer ends of the docks (i.e. Stations 21C, 22C, and 25C), probably caused by scour from the propeller wash. Station 25A, near the Clark Drive/Vernon Relief combined sewer overflows, consisted of raw sewage. A thick white layer of bacteria covered the surface of the sample. Bacteria counts (MPN/100g >2.5 million) by Environmental Protection in June 1986 confirmed the composition (Appendix D). Tidal flow in this region is severely restricted by the docks allowing the accumulation of sludge deposits. Sunken logs and concrete debris were often caught in the otter trawl when fishing along the south shore. In the centre on the harbour, the trawl was frequently full of wood debris indicative of past dumping. East of Second Narrows, the bottom was largely sand, gravel and rocks. Absence of fine sediment would likely preclude significant accumulations of chemical contaminants in this area.

Sediments in Port Moody Arm were generally very fine. Sites along the north shore and areas near the Ioco townsite had black sediment smelling of H_2S. Along Pacific Coast Terminals the surface sediment appeared lighter in colour and lacked the H_2S odour. This region serves as a turning basin for deepsea vessels and is dredged periodically.

Mean surface sediment volatile residues throughout Vancouver Harbour are compared in Figure 24. Concentrations in 1985/86 ranged from 17,533 (Station 13B) to 118,000 µg/g (Station 41). Most stations in Port Moody Arm exceeded 100,000 µg/g. Refer to Appendix D for details.

4.1.4 Bacteria Content

Sediment total coliform, fecal coliform, and fecal streptococci counts are given in Table 8 for 13 sites (N=28) along the south shore of the inner harbour. Station 21A is located near a GVRD combined sewer overflow; Station 25A, near the GVRD Clarke Drive/Vernon Relief combined sewer overflows; Station 28, off the GVRD Victoria Drive combined sewer overflow; and Station 30 near a City of Vancouver stormwater discharge. The highest bacteria count (>2.4 million MPN/100g) occurred at Station 25A. Total coliform content from the other locations ranged between 17,000 and 285,000, MPN/100g (Table 8). Natural bacteria counts in sediment would be expected to be around 20 MPN/100g or less (Kay, pers. com.).

TABLE 8 SEDIMENT BACTERIA CONTENT AT SELECTED STATIONS IN VANCOUVER HARBOUR - JUNE 1986 (MPN/100 g).

Station	Total coliform	Fecal coliform	Fecal streptococci
20A	17 000	2 800	53 000
20B	17 000	2 000	15 000
21A	56 000	22 000	62 500
21C	88 000	13 000	104 500
22A	110 000	22 000	109 500
22C	67 000	15 950	74 500
24	28 000	3 300	144 500
25A	>2 400 000	>2 400 000	>2 400 000
25C	51 000	12 000	35 000
26	190 000	15 450	51 500
27	285 000	2 800	105 000
28	195 000	13 150	185 000
30	100 000	28 000	89 500

Water movement along the south shore is severely restricted by the numerous loading docks. High bacteria counts, high levels of elevated hydrocarbons and trace metals, and the accumulation of sewage sludge off the Clark Drive/Vernon Relief overflows, suggest that much of the material from these combined overflows remains in the immediate area. The highest concentrations of mercury, hydrocarbons and PAH were also found at Station 25A.

4.2 Biota

4.2.1 Species Abundance

During tissue collections each trawl catch was enumerated by species to determine their relative abundance and distribution. These data help to compare the significance of the biota tissue chemical results. Results obtained from 6 surveys between 1985 and 1986, indicate that the harbour continues to support a diverse vertebrate and macroinvertebrate epibenthic community despite the level of contaminants found in the bottom sediments. Flounder, sole, Dungeness crab (*Cancer magister*), and pandalid shrimp were the commercial and recreational species which dominated the catches. Vancouver Harbour catches were much higher relative to other coastal inlets sampled with the same otter trawl. English sole (*Parophrys vetulus*), the most common flatfish, represented up to 88% of the total flatfish catch in some locations. Many were in the small (mean, 22 cm) to medium (mean, 27 cm) size class, suggesting that Vancouver Harbour is used as a rearing area. The most common pandalid shrimp were pink shrimp (*Pandalis borealis*) and sidestripe shrimp (*Pandalopsis dispar*), to a lesser extent, the humpback (*Pandalis hypsinotus*) and coonstripe (*Pandalis danae*) shrimps. The highest catches of shrimp occurred along the West Vancouver shore (Station PEI) and entrance to Coal Harbour. Crab catches were generally higher in the inner harbour and Port Moody Arm. Detailed results on the numbers and species caught at each trawl location are given by Goyette and Thomas (1987).

4.2.2 Trace Metals in Tissue

Numerous benthic invertebrate and demersal fish species were collected for trace metal analysis of muscle, liver/hepatopancreas, and gill tissue. Detailed results are given in Appendix E. Although initially (May 1985) a variety of species were sampled, efforts concentrated on Dungeness crab, 4 species of pandalid shrimp (P. borealis, P. danae, P. hypsinotus and Pandalopsis dispar), and English sole, in subsequent surveys. Table 9 summarizes the range of tissue trace metal concentrations for these species (1985/86). Figures 2 - 4 in Appendix E show the mean concentrations at each site.

Table 9. Summary Table Showing The Ranges in Mean Tissue Trace Metal Concentration (µg/g dry weight), Dungeness crab, Pandalid shrimp and English sole - Vancouver Harbour, 1985 - 1986

	Trace Metal Concentration (µg/g, dry wt.)													
Species	As		Cd		Cr		Cu		Hg		Pb		Zn	
	Max.	Min.	Max.	Min	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
Dungeness Crab														
Muscle	5	64	0.04	0.46	0.4	2.1	29	75.9	0.11	1.28	0.1	2.7	122	233
Hepatopancreas	11	51	0.08	4.0	0.5	4	8.7	888	0.02	1.06	0.26	2.96	60	175
Gill	0.4	2.2	0.4	2.18	0.8	17.7	106	371	0.06	0.38	0.23	75.0	73.3	427.7
Pandalid Shrimp														
Muscle	14	50	0.04	0.73	0.4	1.6	11.5	30.4	0.06	0.54	0.09	1.43	43.9	61.4
Hepatopancreas	13	67	2.2	31.2	0.4	3.0	274	1350	0.06	0.27	0.29	2.15	60.7	132.5
English sole														
Muscle	19	123	0.04	0.51	0.5	2.1	0.4	4.6	0.19	0.50	0.08	1.59	5.1	39.8
Liver	8	64	0.10	5.1	0.5	1.3	6.1	64.1	0.09	0.41	0.7	6.5	82.3	169.5
Gill	4	9	0.04	2.1	1.1	3.3	2.8	24.6	0.05	0.42	0.09	6.0	46.5	108

Generally, there was no evidence of metal uptake in the species examined during the study, despite the elevated metal levels in the surrounding sediments. Metal concentrations in English sole and shrimp muscle were similar to those reported from unpolluted and coastal areas in B.C. (Harding and Goyette, 1989). Detailed statistical analysis, which is beyond the present scope of the study, is required to determine if subtle trends masked by the natural variability in the data are present. Tissue trace metal levels in a few selected offshore species represents only one aspect associated with trace metal contamination in Vancouver Harbour. Sediment toxicity arising from the accumulation of one or more of the trace metals, synergistic effects between metals, and uptake in other species, particularly intertidal species, requires further examination. Sediment from areas in Vancouver Harbour contaminated with trace metals has been shown by earlier studies to be toxic to amphipods (Section 4.3) and concentrations in a number of areas in the harbour exceeded the Puget Sound Benthic AET values.

4.2.3 PAH Concentrations in Tissue

Results of the PAH in Dungeness crab (muscle and hepatopancreas) and English sole (muscle and liver) collected from Vancouver Harbour in January and September 1986 are detailed in Appendix F. The January data are considered questionable because agreement between blind split replicates was poor. The September samples were analyzed by another lab and agreement between blind duplicates was good. PAH concentrations in English sole muscle and liver from September were all below detection (0.01 µg/g). This is expected since most fish are capable of metabolizing PAH into compounds that are undetectable when analyzing for the parent PAH compounds. For crab samples, PAH concentrations were generally below detection, however, trace amounts of anthracene/phenanthrene (up to 0.17 µg/g) were found in hepatopancreas samples from Coal Harbour. Trace levels were also observed in crab hepatopancreas from PEI and Port Moody Arm (Ioco), as well as crab muscle tissue from Ioco.

In 1988, frozen 1986 Dungeness crab tissue from the harbour and samples collected by Department of Fisheries and Oceans in 1988 from False Creek and upper Indian Arm, were analyzed for PAH content. Results are summarized in Table 10. The general detection limit was 0.02 µg/g except for indeno(1,2,3-c,d)pyrene, dibenzo(a,h)anthracene and benzo(g,h,i)perylene which was 0.06 µg/g. Some reported values were below the general detection limits. However, when at least two ions were present for confirmation, but concentrations registered less than the set method detection limit (0.02 µg/g), semi-quantitative PAH levels were estimated (Enviro-Test Laboratories, 1989). Tissue PAH concentrations appeared to correspond to the level of background PAH contamination in the receiving environment. Measurable values were found in both muscle and hepatopancreas from False Creek, Ioco and Coal Harbour. Historically, False Creek has had total PAH levels up to 332 µg/g in the marine sediments taken from the east basin (Greater Vancouver Regional District, 1987). Crab samples in this area showed the highest concentrations in both muscle and hepatopancreas, as well as have the most LPAH and HPAH compounds present (including benzo(a)pyrene) (Table 10). Total PAH in muscle tissue ranged from 0.025 - 0.169 µg/g; hepatopancreas, from 0.148 - 1.24 µg/g. In the Ioco samples, PAH were present, predominantly as LPAH. Levels in the hepatopancreas were higher than muscle tissue with total PAH concentrations ranging up to 0.996 µg/g. Muscle samples were between 0.01 - 0.02 µg/g. The Ioco samples were collected from an area where sediment total PAH concentrations were 4.87 - 21.8 µg/g in 1987. PAH averaged 7.5 µg/g throughout Port Moody Arm (Section 4.1.2.2.).

Exposure of crabs to PAH in the Coal Harbour area should be less than that of False Creek and Port Moody Arm. Sediment total PAH concentrations in the area of capture (Stations 17 and 19) were 5.7 - 7.0 µg/g. There was no evidence of PAH in crab from either Station PEI in the outer harbour or Indian Arm. At PEI, sediment total PAH levels in 1985/86 and 1987 were 1.45 and 1.76 ug/g, respectively. In Indian Arm PAH levels would be expected to be very low.

TABLE 10. RANGE OF PAH CONCENTRATIONS ($\mu g/g$, dry weight) IN DUNGENESS CRAB TISSUE SAMPLED FROM VANCOUVER HARBOUR (1986 and 1988)

SAMPLE LOCATION:	PEI	COAL HARBOUR		IOCO		FALSE CREEK		UPPER INDIAN ARM	
	Hepato (N=2)	Hepato (N=3)	Muscle (N=3)	Hepato (N=4)	Muscle (N=6)	Hepato (N=3)	Muscle (N=3)	Hepato (N=3)	Muscle (N=3)
LOW MOLECULAR WEIGHT POLYCYCLIC AROMATIC HYDROCARBONS (LPAH)									
Napthalene	ND	ND - 0.021	ND	ND - 0.080	ND	0.021 - 0.076	0.01 - 0.069	ND	ND
Acenapthylene	ND	ND	ND	ND - 0.01	0.006 - 0.01	0.01 - 0.024	ND - 0.01	ND	ND
Acenaphthene	ND	0.020 - 0.46	ND - 0.028	ND - 0.18	0.005 - 0.01	0.039 - 0.27	0.005 - 0.01	ND	ND
Fluorene	ND	ND - 0.067	ND - 0.01	ND - 0.17	ND	0.01 - 0.06	0.005 - 0.01	ND	ND
Phenanthrene	ND	ND - 0.015	ND	ND - 0.27	ND	0.01 - 0.15	0.005 - 0.015	ND	ND
Anthracene	ND	ND	ND	ND - 0.076	ND	0.005 - 0.061	ND - 0.005	ND	ND
TOTAL LPAH:	ND	ND - 0.563	ND - 0.038	ND - 0.786	0.011 - 0.02	0.095 - 0.641	0.025 - 0.119	ND	ND
HIGH MOLECULAR WEIGHT POLYCYCLIC AROMATIC HYDROCARBONS (HPAH)									
Fluoranthene	ND	ND	ND	ND - 0.11	ND	0.01 - 0.19	ND - 0.01	ND	ND
Pyrene	ND	ND	ND	ND - 0.10	ND	0.01 - 0.14	ND - 0.01	ND	ND
Benzo(a)anthracene	ND	ND	ND	ND	ND	0.01 - 0.059	ND - 0.01	ND	ND
Chrysene	ND	ND	ND	ND	ND	0.023 - 0.14	ND - 0.01	ND	ND
Benzo(b)fluoranthene + Benzo(k)fluoranthene	ND	ND	ND	ND	ND	ND - 0.052	ND - 0.005	ND	ND
Benzo(a)pyrene	ND	ND	ND	ND	ND	ND - 0.021	ND - 0.005	ND	ND
Indeno(1,2,3-c,d)pyrene	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibenzo(a,h)anthracene	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(g,h,i)perylene	ND	ND	ND	ND	ND	ND	ND	ND	ND
TOTAL HPAH:	ND	ND	ND	ND - 0.21	ND	0.053 - 0.602	ND - 0.05	ND	ND
TOTAL PAH:	ND	ND - 0.903	ND - 0.038	ND - 0.996	0.011 - 0.02	0.148 - 1.24	0.025 - 0.169	ND	ND

ND = <0.02 $\mu g/g$ except for Indeno(1,2,3-c,d)Pyrene, Dibenzo(a,h)Anthracene, Benzo(g,h,i)Perylene which is <0.06 $\mu g/g$

As briefly discussed in Section 4.1.2.2, a number of the HPAH compounds are potentially carcinogenic (National Academy of Sciences, 1972). The International Agency for Research in Cancer (IARC) (1987) has classified carcinogenic agents into 4 Groups as follows:

Group 1 - significant evidence of carcinogenicity in humans to define the agent as carcinogenic to humans.

Group 2A - limited evidence of human carcinogenicity and sufficient evidence of carcinogenicity in animals, suggest that the agent is probably a human carcinogen.

Group 2B - based on inadequate evidence of carcinogenicity in humans and sufficient evidence of carcinogenicity in animals, the agent is defined as a possible human carcinogen.

Group 3 - insufficient human and limited animal data does not justify the classification of the agent as a possible human carcinogen but the evidence suggesting the lack of carcinogenicity is missing.

Group 4 - there is evidence, both human and animal, suggesting that the agent is probably not carcinogenic to humans.

Of the PAH compounds measured, benzo(a)anthracene and benzo(b)pyrene fall under Group 2A; benzo(b)fluoranthene, benzo(k)fluoranthene and indeno(1, 2, 3-c,d)pyrene, under Group 2B. Group 3 compounds consist of anthracene, benzo(g,h,i)pyrene, chrysene, phenanthrene and pyrene.

In terms of human risk assessment, no distinctions are made between Groups 1, 2A, and 2B. Experimental evidence does not allow quantitative risk assessment of several Group 3 substances. Taking the most recent data set (Table 10), only the samples from False Creek contained Group 2A and 2B PAH compounds. Results suggest that relatively high sediment PAH concentrations are required to cause a measurable increase in crab tissues PAH concentration. However, considering the limited sample size, more intensive sampling in the harbour is required. This should include crab and other important species (e.g. bivalves) to determine the significance of tissue PAH concentrations from both a biological and human health standpoint. According to Uthe (1979), allowable levels of total PAH in the edible portions, if set, would likely be about 0.1 µg/g, (or 0.001 µg/g, benzo(a)pyrene), the highest PAH levels naturally observed in foodstuffs. These values were exceeded in some crab tissue samples from 1988, in particular the hepatopancreas in crabs from False Creek, Port Moody (IOCO) and Coal Harbour.

4.2.4 Flatfish Tissue Abnormalities

4.2.4.1 External Abnormalities. Evidence of fin erosion and skin papillomas has been found in various fish species including flatfishes. Skin papillomas are thought to be caused by a protozoan (amoeba) infection but the higher percentages found around urban centres suggest a possible link to environmental conditions. Although found in remote, nonurban areas (Nigrelli et al., 1965; Wellings et al., 1976; Stich et al., 1977), they appear to be more prevalent around urban centres (Stich et al., 1976). Stitch et al. (1977) reported frequencies ranging from 7.0 - 58.6% at various urban centres along the Pacific Coast, including the Vancouver area. The upper limit was observed in flatfish from the Fraser River estuary. Nonurban areas were less than 1%. More recent studies in the Fraser estuary have reported skin papillomas up to 92% in Rex sole (Fanning et al., 1989).

During the Vancouver Harbour surveys, all flatfish caught were examined visually for external lesions (approximately 10,000 fish). Some individuals had external parasites, abnormal red colouration and skin papillomas. The number of fish affected by skin papillomas, however, was low (<5%) (Goyette et al., 1988), predominantly English and rex soles. The latter species was found mainly in the outer harbour (Station PEI).

4.2.4.2 Liver Lesions. In the present study, the number of English sole (Parophrys vetulus) affected by idiopathic (non-parasitic, non-infectious) liver lesions was significant. Prevalence of the lesions was strongly dependent on the area of capture. Idiopathic lesions have been linked primarily with exposure to anthropogenic chemical in the sediments, in particular, the polycyclic aromatic hydrocarbons (PAH) (Malins et al, 1988). Since liver lesions were shown to be more prevalent in fish from polluted urban areas compared with nonurban areas, they have been used as indicators for the end point effect of xenobiotic chemicals. Much of this data has come from the Puget Sound area (Malins et al. 1984, 1985, 1988; McCain et al. 1988; Myers et al. 1987). Malins et al. (1985) concluded that environments which induce liver lesions (or neoplasia) in fish are likely responsible for a number of other changes at the organism and ecosystem level, many of which have yet to be recognized.

Three types of idiopathic liver lesions are important because of their morphological similarities to lesions found in laboratory mammals and fishes following exposure to toxic chemicals. They include preneoplastic lesions (foci of cellular alteration - clear cell, basophilic and eosinophilic foci); neoplastic lesions (liver cell adenoma, hepatocellular carcinoma); and a degenerative condition (megalocytic hepatosis) (Myers et al., 1987). Preneoplastic lesions, particularly the basophilic and eosinophilic foci, are generally considered precursors to tumor development. The presence of preneoplastic and neoplastic lesions in fish from nonurban or undisturbed coastal areas is very low or non existent.

In September 1986, English sole samples were collected at various stations in Vancouver Harbour and examined histologically for idiopathic lesions. Detailed results with descriptions of the lesion types observed have been reported by Goyette et al. (1988). The study was repeated in 1987 including Loughborough Inlet as a reference site. Additional histochemical analysis (PAS for glycoproteins and mucopolysaccharides; Prussian Blue for ferric iron) was also included for verification of the histological observations

Detailed results of the 1987 study are included in Appendix G. The percentage of English sole affected by neoplastic and preneoplastic liver lesions for the two studies are summarized in Table 11 and illustrated in Figure 25. The three types of idiopathic liver lesions are compared by station in Table 12 and illustrated in Figure 26.

In 1986, the prevalences of preneoplastic and neoplastic lesions in English sole ranged from 8.3 to 58.8% (Brand, 1987; Goyette et al., 1988). The highest occurred in Port Moody Arm where sediment hydrocarbon, PAH, and certain trace metals levels were relatively high. In the outer harbour (Station PEI), 13.3% of the fish were affected by both types of lesions. Along the south (Coal Harbour) and north shores (Burrard Yarrows) of the inner harbour, percents were 10 and 30%, respectively. The lowest prevalence (8.3%) occurred in the centre of the inner harbour.

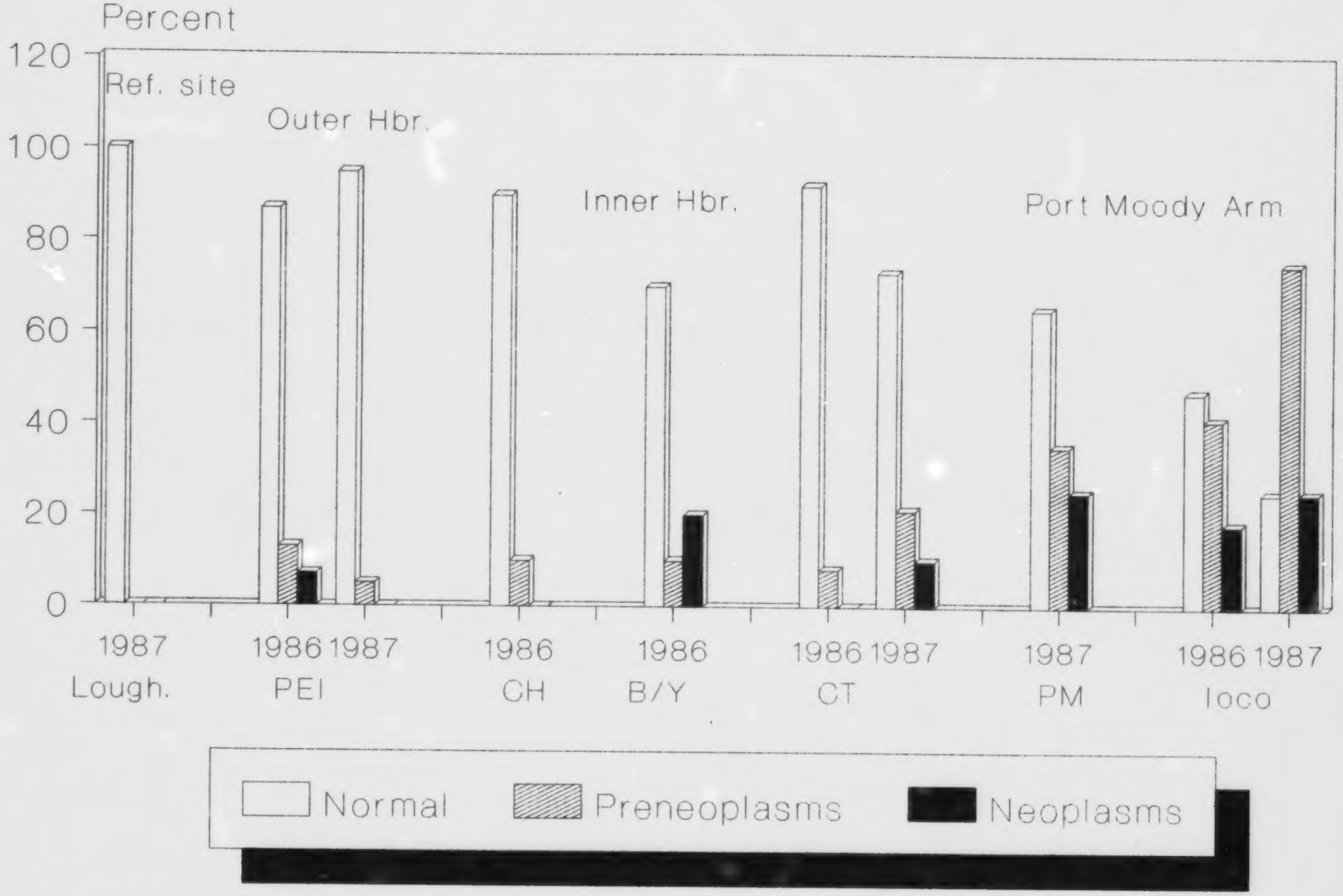
In 1987, percentages ranged from 5.0 to 75.0%. Similar to 1986, the maximum percentage was observed in Port Moody Arm, near the Ioco refinery (Ioco). Visually, livers from fish caught in Port Moody Arm appeared unhealthy, many showing distinct black lines radiating through the tissue, external nodules, and some obviously severely affected by numerous lesions. Prevalence of preneoplastic and neoplastic liver lesions from the inner harbour (Center Channel) and entrance to Port Moody Arm (Port Moody) were 31.6 and 35%, respectively. Particular to the Ioco samples, was the number of fish affected by the different types of idiopathic lesions and the frequency of co-occurences (Figure 26). Co-occurence patterns have been used to indicate the relationships of various preneoplastic lesions to the neoplastic lesions (Myers et al., 1987).

Hepatocellular carcinomas, not observed in 1986, were found in 5.5% of the fish from the Ioco sampling site in 1987. No idiopathic lesions were found in sole from Loughborough Inlet in 1987 (Appendix G). Megalocytic hepatosis, a degenerative liver condition suspected as a precursor to preneoplasms and common in English sole from Puget Sound, did not occur frequently in sole from Vancouver Harbour. The reason for this difference is unclear.

TABLE 11 THREE GROUPS OF IDIOPATHIC LIVER LESIONS (MEGALOCYTIC HEPATOSIS, PRENEOPLASMS AND NEOPLASMS) IN ENGLISH SOLE (PAROPHRYS VETULUS) FROM VANCOUVER HARBOUR – 1986 AND 1987

STATION	N	MEGALOCYTIC HEPATOSIS N (%)	PRENEOPLASTIC LESIONS			NEOPLASTIC LESIONS	
			CLEAR CELL FOCI N (%)	EOSINOPHILIC FOCI N (%)	BASOPHILIC FOCI N (%)	LIVER CELL ADENOMA N (%)	HEPATOCELLULAR CARCINOMA N (%)
PEI							
1986	15	0 (0)	2 (13)	0 (0)	1 (7)	1 (7)	0 (0)
1987	20	0 (0)	0 (0)	0 (0)	1 (5)	0 (0)	0 (0)
Burrard Yarrows							
1986	10	0 (0)	0 (0)	2 (20)	0 (0)	2 (20)	0 (0)
1987	NS	–	–	–	–	–	–
Coal Harbour							
1986	10	1 (10)	0 (0)	1 (10)	0 (0)	0 (0)	0 (0)
1987	NS	–	–	–	–	–	–
Centre Harbour							
1986	12	0 (0)	1 (8)	0 (0)	0 (0)	0 (0)	0 (0)
1987	19	1 (5)	0 (0)	3 (16)	2 (11)	2 (11)	0 (0)
Port Moody							
1986	NS	–	–	–	–	–	–
1987	20	0 (0)	1 (5)	6 (30)	6 (30)	5 (25)	0 (0)
Ioco							
1986	17	1 (6)	2 (12)	1 (6)	5 (29)	3 (18)	0 (0)
1987	16	0 (0)	2 (12)	10 (62)	10 (62)	4 (25)	3 (19)
Loughborough Inlet (Reference Site)							
1986	NS	–	–	–	–	–	–
1987	6	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

NS – Not Sampled



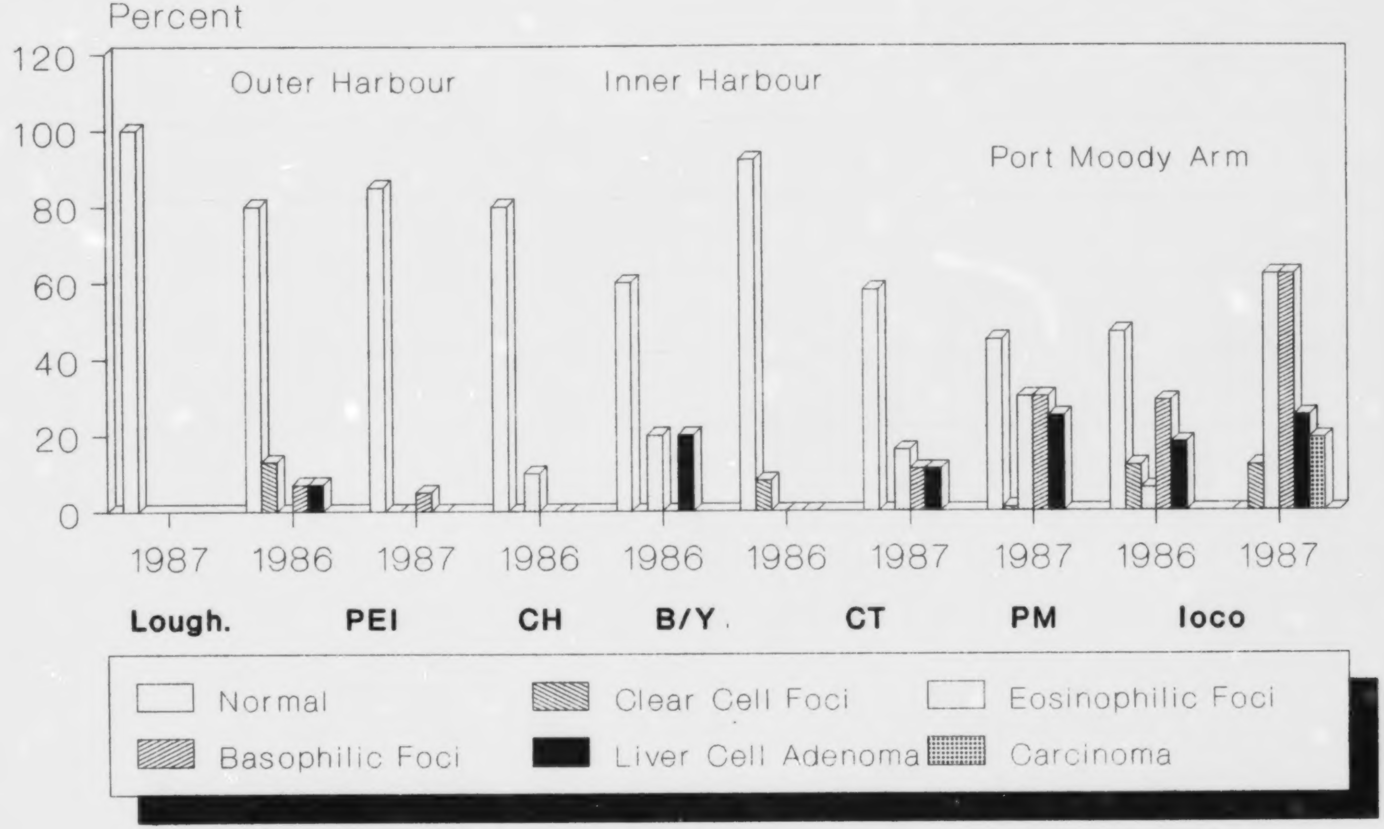
PEI = Pacific Environment Institute
CH = Coal Hbr. B/Y = Burrard Yarrows
CT = Centre Channel PM = Port Moody
Lough. = Loughborough Inlet (reference site)

FIGURE 25. **PERCENT NORMAL VS. NEOPLASTIC AND PRENEOPLASTIC LIVER LESIONS IN ENGLISH SOLE (PAROPHRYS VETULUS) FROM VANCOUVER HARBOUR (1986 AND 1987) AND LOUGHBOROUGH INLET (1987).**

TABLE 12. PREVALENCE OF PRENEOPLASMS AND NEOPLASMS IN THE LIVER OF ENGLISH SOLE (Parophrys vetulus) FROM VANCOUVER HARBOUR - 1986 AND 1987

STATION	N	PRENEOPLASMS N (%)	NEOPLASMS N (%)	PRENEOPLASMS/NEOPLASMS EITHER N (%)	PRENEOPLASMS/NEOPLASMS CO-OCCURENCE N (%)
PEI					
1986	15	2 (13)	1 (7)	2 (13)	1 (7)
1987	20	1 (5)	0 (0)	1 (5)	0 (0)
Burrard Yarrows					
1986	10	2 (20)	1 (10)	3 (30)	1 (10)
1987	NS	-	-	-	-
Coal Harbour					
1986	10	1 (10)	0 (0)	1 (10)	0 (0)
1987	NS	-	-	-	-
Centre					
1986	12	1 (8)	0 (0)	1 (8)	0 (0)
1987	19	4 (21)	2 (11)	5 (26)	1 (5)
Port Moody					
1986	NS	-	-	-	-
1987	20	7 (35)	5 (25)	7 (35)	5 (25)
Ioco					
1986	17	7 (41)	3 (18)	9 (53)	1 (6)
1987	16	12 (75)	4 (25)	12 (75)	4 (25)
Loughborough Inlet (Reference Site)					
1986	NS	-	-	-	-
1987	6	0 (0)	0 (0)	0 (0)	0 (0)

NS - Not Sampled



PEI = Pacific Environment Institute
CH = Coal Harbour B/Y = Burrard Narrows Lough. = Loughborough Inlet (Reference site)
CT = Centre Channel PM = Port Moody

FIGURE 26. COMPARISON OF INDIVIDUAL NEOPLASTIC AND PRENEOPLASTIC LIVER LESIONS OBSERVED IN ENGLISH SOLE (PAROPHRYS VETULUS) IN VANCOUVER HARBOUR (1986 AND 1987) AND LOUGHBOROUGH INLET (1987).

Areas within Puget Sound have been rated according to the prevalence of neoplasms, preneoplasms and megalocytic hepatosis (Evans-Hamilton and D.R. Systems, 1987). Myers et al. (1987) has shown a significant link between megolocytic hepatosis and preneoplastic lesions (foci of cellular alteration) suggesting the former as an early indication of hepatocarcinogen-hepatotoxin exposure. Areas of primary concern are those having >5% neoplasms, >15% preneoplasms and >15% megalocytic hepatosis in the target species, English sole. Secondary areas are those with 2.5 - 5% neoplasms, 5 - 15% preneoplasms and 5% to 15% megalocytic hepatosis. Percentages of neoplasms and preneoplasms in English sole from the various sampling locations in Vancouver Harbour in 1986 and 1987 are shown in Table 11. Megalocytic hepatosis in fish from Vancouver Harbour was very low (1.3 - 1.9%) compared to Puget Sound (up to 86%) (Evans-Hamilton and D.R. Systems, 1987). Percentages of each type of lesion are provided in Table 12. The types of neoplastic and preneoplastic lesions in English sole from Vancouver Harbour were similar to those found in urban embayments in Puget Sound. All sampling locations in the harbour fell within either the primary or secondary areas of concern established for Puget Sound.

Hepatic lesions in English sole, living in direct contact with the bottom, have been linked to sediment-associated aromatic hydrocarbons which includes PAH (Malin et al., 1984, 1985, 1988; Myers et al., 1987). PAH metabolites can bind to proteins and nucleic acid (DNA) resulting in molecular deformation, cell damage and eventually in mutations, cancer or teratogenic effects (Knutzen, 1987, Neff, 1979). As little as 1 µg/g, total sediment PAH is required to cause biochemical effects in winter flounder (Pseudopleuronectes americanus) (Payne et al., 1988). A number of idiopathic lesions have been found in wild fish from PAH contaminated areas and reproduced in the laboratory through intermuscular and embryo micro-injections of sediment extracts (Black et al., 1988; Metcalfe et al., 1988). Krahn et al. (1986) found high concentrations of aromatic compound metabolites in English sole bile from Eagle Harbour and Duwamish Waterway, two areas in Puget Sound containing high sediment PAH levels. Concentrations in reference fish were at least 20 times lower.

While the exact cause/effect relationship between sediment contaminants and liver lesions in English sole remains uncertain and other contaminants besides PAH can cause or promote tumor development in fish, PAH appear to play a major role. For example, percentages of neoplastic and preneoplastic lesions in English sole from Eagle Harbour, site of a creosote plant, were 32% and 52%, respectively (Evans-Hamilton and D.R. Systems, 1987). Sediment HPAH concentrations in Eagle Harbour ranged from 10.4 - 63.9 µg/g. In Everett Harbour (HPAH, 0.74 - 56.0 µg/g), prevalences of the two types of hepatic lesions were 12% and 25%. In Commencement Bay (HPAH, 0.057 - 10.2 µg/g), prevalences were 8% and 27%, respectively. In Sinclair Inlet, where HPAH levels averaged 6.7 µg/g (2.0 - 29.0 µg/g) along the shoreline, the prevalences of preneoplastic lesions in fish caught offshore ranged from 1.7 - 30%. Percentages of neoplastic lesions ranged from 0 - 6.7%. In Budd Inlet, an area where HPAH levels were low (0.35 - 0.69 µg/g), neoplastic and preneoplastic lesions were not detected in English sole.

Although English sole exhibit seasonal migrations, studies indicate that they have strong homing instincts. From tagging studies, Day (1976) found that fish caught in Puget Sound rapidly returned to their area of capture. Sharp contrasts between the high prevalences of liver lesions in fish from contaminated embayments in Puget Sound and nearby offshore areas (Evans-Hamilton and D.R. Systems, 1987) also suggests that English sole occupy relatively small territories. In Vancouver Harbour, the distance and geographical restrictions between Port Moody Arm and the inner harbour, coupled with the strong tidal currents, suggests that the English sole population in Port Moody Arm is relatively isolated from the remainder of the harbour. If one assumes that: PAH are the primary cause of the liver lesions in English sole from Vancouver Harbour and those fish in Port Moody Arm belong to distinct populations which are exposed only to local sediment PAH concentrations then, sediment HPAH concentrations of 3.3 - 4.4 µg/g (1987), result in a 35% prevalence of preneoplastic and neoplastic lesions and 4.5 - 18.8 µg/g in a 75% prevalence. Throughout Port Moody Arm, HPAH levels in 1987 ranged from 3.0 - 32.0 µg/g (mean, 7.5 µg/g) (Table 6).

In the rest of the harbour, where the movements of English sole and levels of PAH exposure are more difficult to predict, sediment HPAH concentrations of 1.1 - 5.5 μg/g (Station 14 and 19, respectively) were associated with lesion prevalences of 10 - 30%. HPAH levels in the foreshore areas along the south shore of the inner harbour, away from the area of capture (Station 22A), were 6.6 and 9.9 μg/g in 1985/86 and 1987, respectively.

More information on the movements of English sole in Vancouver Harbour and the cause/effect relationships between sediment associated PAH and prevalences of English sole liver lesions is required before definite conclusions can be drawn. However, data from Vancouver Harbour and elsewhere, suggest that the sediment PAH concentration required to cause liver lesions in English sole are 3 - 4 μg/g, or possibly lower.

4.2.5 Benthic Infauna

In October 1987, macrobenthic infauna sampling was conducted at 28 sites by the Institute of Ocean Sciences (Burd and Brinkhurst, in prep.), in conjunction with the current program. No historical information is available which predates industrial and urban development to evaluate what constitutes a normal or "healthy" benthic community in Vancouver Harbour. However, preliminary analysis of the data shows a much healthier infauna community in the inner harbour than would be expected based on the levels of contaminants. Several stations in Port Moody Arm were severely depauperate.

A cluster analysis showed some obvious differences between groups of stations. One group in particular included a small group of stations on the north shore near Vancouver Wharves (Stations 1 - 4A) and one south shore station (Station 25B). Another groups consisted of the remaining stations in the inner harbour (Stations 11B, 15, 16, 19, 22D, 22E, 25D and 25E). At three Port Moody Arm stations fauna, were essentially absent (Stations 41B, 45 and 46). The reference station (Station PEI) appeared to cluster with the stations in the middle of the inner harbour, away from the nearshore stations. All of these groups are statistically significant (Burd and Brinkhurst, in prep.) but have yet to be tested for agreement between clusters based on chemical data or sediment type and those derived from benthic studies. A preliminary inspection of the data shows that there is a richer fauna, in terms of number of individuals, and even some stations with more species at some inner harbour stations, than the reference site (PEI). Chemical analysis of surface sediments from Station PEI during the present study, however, indicates some contamination, particularly with respect to copper (see Section 4.1.1.4).

4.3 Sediment Toxicity

4.3.1 Amphipod Bioassays

Sediment toxicity test using the amphipod (Rhepoxynius abronius) have been conducted for a number of coastal areas in B.C., including Vancouver Harbour, under Ocean Dumping Research Funding (Chapman and Barlow, 1984; Chapman et al., 1988, 1989). Although the purpose was to evaluate the tiered testing approach using the Sediment Quality Triad (sediment toxicity, sediment chemistry and benthic infauna) results provided a measure of the sediment toxicity at the various locations in the harbour. Percent survival was determined from 20 amphipods exposed to sediment samples for 10 days. Based on three separate studies, these varied from 0% to 18.6 ± 1.5%. The most toxic sediments came from sites near Vancouver Wharves (Stations 1, 2, and 3B) and Pacific Coast Terminals (Stations 45 and 46). Survival ranged from 0% to 7.8 ± 2.3% for these stations (Chapman et al., 1989). The centre of the inner harbour (Station 15), south shore (Station 22B, 25B), and Port Moody Arm (Stations 36B, 40, 41A, and 41B) ranged from 17.0 ± 3.9% to 18.6 ± 1.5% survival. Only Stations 22B, 25B and 36B of the latter group were significantly different from the controls. Using the current data, high toxicities did not always correspond to the highest concentrations of measured contaminants. However, the samples were not collected concurrently with the sediment bioassay samples nor was the full spectrum of chemical contaminants analyzed.

4.3.2 Macoma Bioassays

Toxicity tests using the bivalve, Macoma sp. have also been conducted by the Provincial Waste Management Branch on sediment samples from Port Moody Arm (B. Moore, pers. com.). Mortalities ranged from 0 - 29% in samples taken along the north shore near the Ioco refinery and townsite. Along the south shore, near Pacific Coast Terminals, the percent mortalities ranged from 5 - 39%.

4.4 Conclusions

Overall, the results from this study do not suggest that the environment in Vancouver Harbour is severely degraded. The harbour continues to support a variety of epibenthic species along with a relatively rich infaunal community. There was no evidence of significant metal uptake in selected benthic species captured in areas offshore from the more heavily contaminated foreshore areas. Nevertheless, sediments in a number of areas of the harbour are seriously contaminated with trace metals and certain organic chemical contaminants associated with urban and industrial activities. This has resulted in the pathological effects to some segments of the bottomfish populations in the harbour, raising questions concerning biota survival and level of chemical carcinogens in the marine environment. As well, sediments from some locations are highly toxic to test organisms and results of studies show that the benthic community occurs in distinct groups or clusters implying alterations to the community structure which requires further investigation.

5.0 Remedial Actions

As a result of this and other studies, a number of remedial measures are presently being implemented to address environmental concerns in Vancouver Harbour. In cooperation with Environment Canada, B.C. Waste Management Branch, and other regulatory agencies, Greater Vancouver Regional District (GVRD) has undertaken a study to identify short-term and long-term actions necessary to improve environmental conditions in Vancouver Harbour. The provincial Ministry of Environment is presently drafting Water Quality Objectives for Burrard Inlet (Vancouver Harbour). Current legislation under the Ocean Dumping provisions of the federal Canadian Environmental Protection Act (CEPA) and evaluation of various chemical substances under the CEPA Priority Substance List will govern the dredging and disposal of contaminated material from the harbour. An interim screening limit of 2.5 µg/g, total PAH has been proposed for ocean disposal while a more detailed assessment is carried out.

As of March 1989, treated process water from the Esso Petroleum Ioco Refinery, which was discharged directly to Port Moody Arm, has been diverted to the GVRD sewer system. In addition, the company has undertaken a detailed wastewater chemical characterization and stormwater segregation program. Similar wastewater characterization programs are either underway or proposed for other refinery operations in the harbour. Wastewater from the sulphur storage area at the Pacific Coast Terminals operation in Port Moody Arm has also been diverted to the GVRD sewer system, along with facility modifications to prevent waste seepage into the harbour. Vancouver Wharves, which was identified as a major source of metal contamination in the inner harbour, removed a significant quantity of the contaminated material from the loading dock area in September 1989 to increase the draft for deepsea vessels. Further inspection is required to assess this source of metal contamination in the inner harbour.

Steps to control spillage during the loading and unloading of bulk commodities and the treatment of stormwater and combined sewer overflows will be needed. Further information is also required on the relationships of sediment contaminants, in particular PAH, to pathological effects on a number of species in the harbour and on tissue contaminant levels and risks to human health through consumption of seafood.

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ENVIRONMENT CANADA
CONSERVATION AND PROTECTION
ENVIRONMENTAL PROTECTION
PACIFIC AND YUKON REGION

DISTRIBUTION AND ENVIRONMENTAL IMPACT OF SELECTED BENTHIC CONTAMINANTS IN VANCOUVER HARBOUR, BRITISH COLUMBIA

APPENDICES

1985 TO 1987

Regional Program Report: 89-02

by

D. Goyette
J. Boyd

OCTOBER 1989

REVIEW NOTICE

This report has been reviewed and approved for publication by the Marine Programs Division, Environmental Protection. Readers may direct comments or questions to:

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LIST OF APPENDICES

APPENDIX	
A	Thomas, M. and D. Goyette. 1989. Vancouver Harbour Benthic Environmental Quality Studies - May 1985 to September 1986. **Trace Metals in Sediment**. Environment Canada, Conservation and Protection.
B	Thomas, M. and D. Goyette. 1989. Vancouver Harbour Benthic Environmental Quality Studies - May 1985 to January 1986. **Organic Compounds in Sediment**. Environment Canada, Conservation and Protection.
C	Boyd, J., B. Raymond and D. Goyette. 1989. Vancouver Harbour Benthic Environmental Quality Studies. **Trace Metals and Organic Compounds in Sediments - October 1987**. Environment Canada, Conservation and Protection.
D	Thomas, M. and D. Goyette. 1989. Vancouver Harbour Benthic Environmental Quality Studies - May 1985 to September 1986. **Sediment Particle Size Distribution, Residue and Bacteria Content**. Environment Canada, Conservation and Protection.
E	Thomas, M. and D. Goyette. 1989. Vancouver Harbour Benthic Environmental Quality Studies - May 1985 to January 1986. **Trace Metals in Tissues**. Environment Canada, Conservation and Protection.
F	Thomas, M. and D. Goyette. 1989. Vancouver Harbour Benthic Environmental Quality Studies - May 1985 to September 1986. **Polycyclic Aromatic Hydrocarbons in Sole and Crab Tissues**. Environment Canada, Conservation and Protection.
G	Brand, D. and D. Goyette. 1989. **Further Studies of the Prevalence of Idiopathic Liver Lesions in English Sole, *Parophrys vetulus***, from Vancouver Harbour, British Columbia, 1987. Environment Canada, Conservation and Protection.

APPENDIX A

VANCOUVER HARBOUR BENTHIC ENVIRONMENTAL QUALITY STUDIES
MAY 1985 - SEPTEMBER 1986

TRACE METALS IN SEDIMENT

BY

M. THOMAS
D. GOYETTE

OCTOBER 1989

REVIEW NOTICE

Data reports are prepared to make data available without full analysis or interpretation. This report has been reviewed by the Marine Programs Division, Environmental Protection, and approved for limited distribution. For further information please contact:

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TABLE OF CONTENTS

PAGE

REVIEW NOTICE i

TABLE OF CONTENTS ii

List of Figures iv

List of Tables v

1.0 INTRODUCTION 1

2.0 MATERIALS AND METHODS 2

2.1 Study Area 2

2.2 Field Collection 7

2.3 Laboratory Analysis 7

2.4 Statistical Analysis 8

3.0 RESULTS 9

REFERENCES 28

ACKNOWLEDGEMENTS 29

APPENDIX I - VANCOUVER HARBOUR SAMPLING STATION COORDINATES AND DEPTHS 30

APPENDIX II - SEDIMENT TRACE METAL CONCENTRATIONS IN STANDARD REFERENCE MATERIALS (BCSS-1 AND MESS-1) AND PERCENT RECOVERY BY EP LABORATORY 34

A. MAY 1985 35

B. OCTOBER 1985 36

C. NOVEMBER 1985 37

D. JANUARY 1986 38

E. MAY 1986 39

F. JUNE 1986 40

G. SEPTEMBER 1986 41

TABLE OF CONTENTS (Continued)

PAGE

APPENDIX III - RAW DATA OF SEDIMENT TRACE METAL CONCENTRATIONS 42
- A. MAY 1985 43
- B. OCTOBER 1985 45
- C. NOVEMBER 1985 46
- D. JANUARY 1986 50
- E. MAY 1986 51
- F. JUNE 1986 52
- G. SEPTEMBER 1986 55

APPENDIX IV - DESCRIPTIVE STATISTICS OF SEDIMENT TRACE METALS CONCENTRATIONS 57
- A. MAY 1985 58
- B. OCTOBER 1985 61
- C. NOVEMBER 1985 63
- D. JANUARY 1986 67
- E. MAY 1986 68
- F. JUNE 1986 70
- G. SEPTEMBER 1986 74

LIST OF FIGURES

PAGE

FIGURE 1 - SEDIMENT TRACE METAL SAMPLING STATIONS IN VANCOUVER HARBOUR (1985-86):
(a) OUTER AND INNER HARBOUR 3
(b) CENTRAL HARBOUR AND PORT MOODY ARM 4

FIGURE 2 - MEAN SURFACE SEDIMENT CADMIUM CONCENTRATIONS IN UG/G DRY WEIGHT (1985-86):
(a) OUTER AND INNER HARBOUR 12
(b) CENTRAL HARBOUR AND PORT MOODY ARM 13

FIGURE 3 - MEAN SURFACE SEDIMENT CHROMIUM CONCENTRATIONS IN UG/G DRY WEIGHT (1985-86):
(a) OUTER AND INNER HARBOUR 14
(b) CENTRAL HARBOUR AND PORT MOODY ARM 15

FIGURE 4 - MEAN SURFACE SEDIMENT COPPER CONCENTRATIONS IN UG/G DRY WEIGHT (1985-86):
(a) OUTER AND INNER HARBOUR 16
(b) CENTRAL HARBOUR AND PORT MOODY ARM 17

FIGURE 5 - MEAN SURFACE SEDIMENT IRON CONCENTRATIONS IN UG/G DRY WEIGHT (1985-86):
(a) OUTER AND INNER HARBOUR 18
(b) CENTRAL HARBOUR AND PORT MOODY ARM 19

FIGURE 6 - MEAN SURFACE SEDIMENT MERCURY CONCENTRATIONS IN UG/G DRY WEIGHT (1985-86):
(a) OUTER AND INNER HARBOUR 20
(b) CENTRAL HARBOUR AND PORT MOODY ARM 21

LIST OF FIGURES (Continued)

PAGE

FIGURE 7 - MEAN SURFACE SEDIMENT NICKEL CONCENTRATIONS IN UG/G DRY WEIGHT (1985-86):
(a) OUTER AND INNER HARBOUR 22
(b) CENTRAL HARBOUR AND PORT MOODY ARM 23

FIGURE 8 - MEAN SURFACE SEDIMENT LEAD CONCENTRATIONS IN UG/G DRY WEIGHT (19985-86):
(a) OUTER AND INNER HARBOUR 24
(b) CENTRAL HARBOUR AND PORT MOODY ARM 25

FIGURE 9 - MEAN SURFACE SEDIMENT ZINC CONCENTRATIONS IN UG/G DRY WEIGHT (1985-86):
(a) OUTER AND INNER HARBOUR 26
(b) CENTRAL HARBOUR AND PORT MOODY ARM 27

LIST OF TABLES

PAGE

TABLE 1 - VANCOUVER HARBOUR SEDIMENT SAMPLING SCHEDULE FOR SURVEYS CONDUCTED IN 1985-86 - TRACE METALS IN SEDIMENT 5

TABLE 2 - MEAN SEDIMENT TRACE METAL CONCENTRATIONS OBSERVED IN VANCOUVER HARBOUR FROM 1985-86 10

1.0 INTRODUCTION

Following a literature review of Vancouver Harbour (Waters 1985a,b), Environmental Protection (EP) began a series of benthic environmental studies in May 1985 to document the existing quality of Vancouver Harbour. Emphasis was placed on selected trace metals and organic compounds in surficial bottom sediments, benthic epifauna and demersal fish. Seasonal species abundance and distribution based on otter trawl catches (Goyette and Thomas, 1987) and prevalence of liver tissue abnormalities in flatfish (Goyette et al., 1988), have been reported.

Sediment trace metal levels represent an important parameter to measure the environmental quality of a highly industrialized or urbanized waterway. Potential sources of metal contamination in Vancouver Harbour include bulk loading terminals (metal concentrates), metal finishing plant effluents, shipyards (blasting abrasives, anti-fouling paints, etc.), municipal waste discharges, oil refinery effluents, and general urban runoff. Metals, among other contaminants, tend to adhere to suspended particulates which ultimately settle to the bottom. Accumulation and potential sources of input can be evaluated by measuring the trace metal content of benthic sediment.

Although bioavailability of trace metals from sediment is largely dependent on chemical state and mobility, metal uptake can be toxic to organisms directly in contact with contaminated sediment. Knowledge of spatial and temporal distribution patterns of trace metals can aid in identifying major sources of anthropogenic input as well as providing the basis for assessing the potential biological impact.

This data report documents sediment trace metal levels observed in Vancouver Harbour (Point Atkinson to Port Moody Arm) from May 1985 to September 1986 and is one of a series of reports on benthic studies in Vancouver Harbour being prepared by EP, Environment Canada.

2.0 MATERIALS AND METHODS

2.1 Study Area

Vancouver Harbour was subdivided into four hydrographic regions for study; stations are indicated in brackets.

OUTER HARBOUR - Spanish Banks (SB)
- Point Atkinson (ATK)
- Pacific Environment Institute (PEI)
- Dundarave (DD)

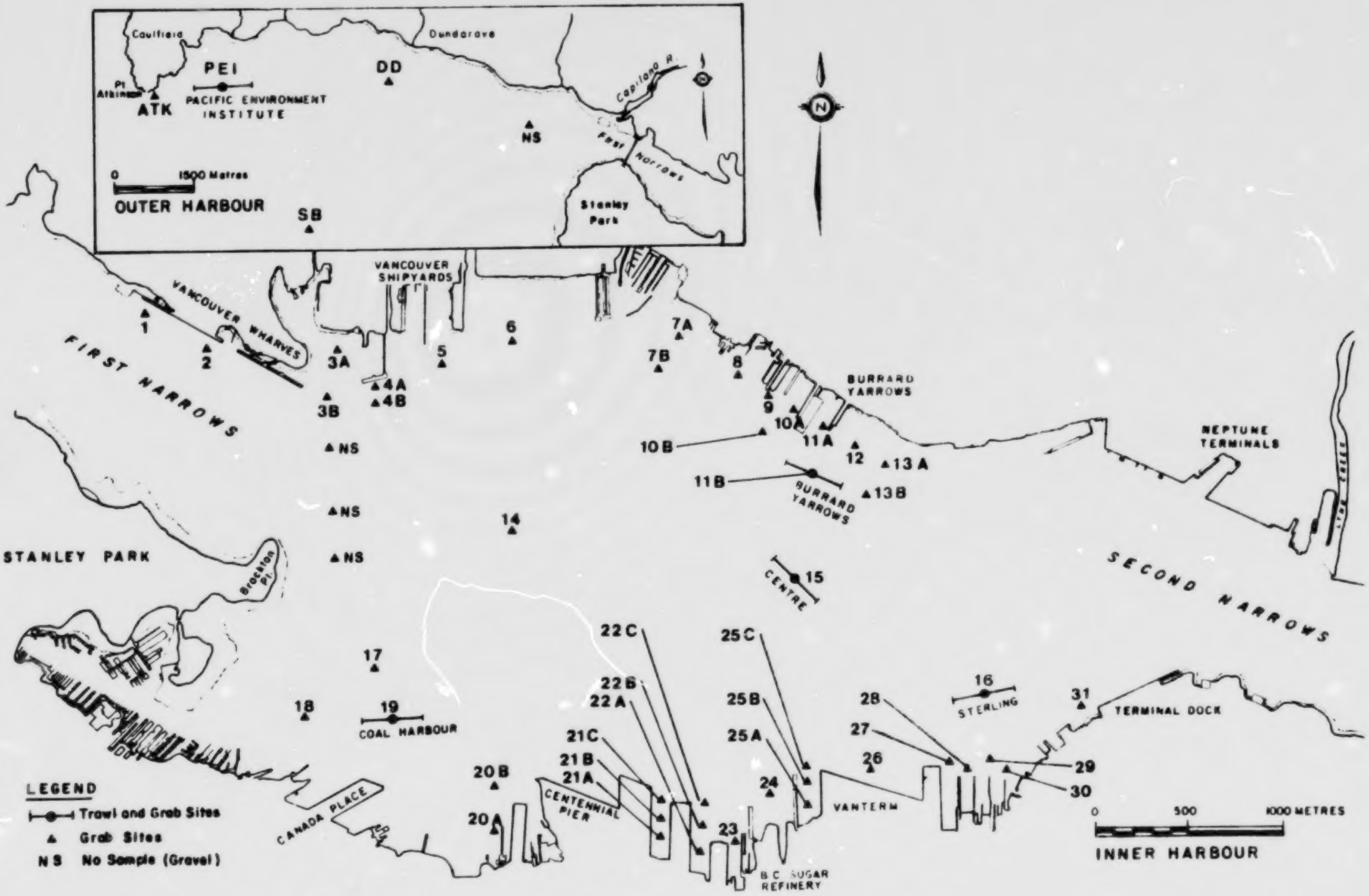
INNER HARBOUR - North Shore (1 to 13B)
- Centre (14 to 16)
- South Shore (17 to 30)

CENTRAL HARBOUR - Cates Park (CP)
- Boulder Rock (BR)

EASTERN HARBOUR - Port Moody Arm (32 to 47)

Sites were selected to evaluate sediment trace metal distribution with respect to specific harbour activities. A total of 73 stations were sampled; 4 in the Outer Harbour, 44 in the Inner Harbour, 2 in the Central Harbour and 23 in Port Moody Arm. Sampling site locations are shown in Figures 1a and 1b. Stations which correspond with otter trawl sampling sites have been indicated on the maps. In addition to sediment, biota samples were collected from these sites for trace metal and organics analyses and will be the subject of future reports.

Seven surveys were conducted from the research vessel C.S.S. Vector during the study period from May 1985 to September 1986. Due to the size of the study area, most sites could be sampled only once. Seven sites (PEI, 11B, 15, 16, 19, 35 and 38) were sampled from 3 to 5 times to compare trace metal concentrations during the study period. The sampling schedule undertaken is indicated in Table 1.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ATK
PEI
PACIFIC ENVIRONMENT INSTITUTE
DD
Dundarave
NS
Capilano R.
First Narrows
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VANCOUVER WHARVES
FIRST NARROWS
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2
3A
3B
4A
4B
5
6
7A
7B
8
9
10A
10B
11A
11B
12
13A
13B
BURRARD YARROWS
NEPTUNE TERMINALS
NS
NS
NS
14
15
CENTRE
STANLEY PARK
Brockton Pt.
SECOND NARROWS
17
18
19
COAL HARBOUR
20A
20B
21A
21B
21C
CENTENNIAL PIER
22A
22B
22C
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B.C. SUGAR REFINERY
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VANTERM
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STERLING
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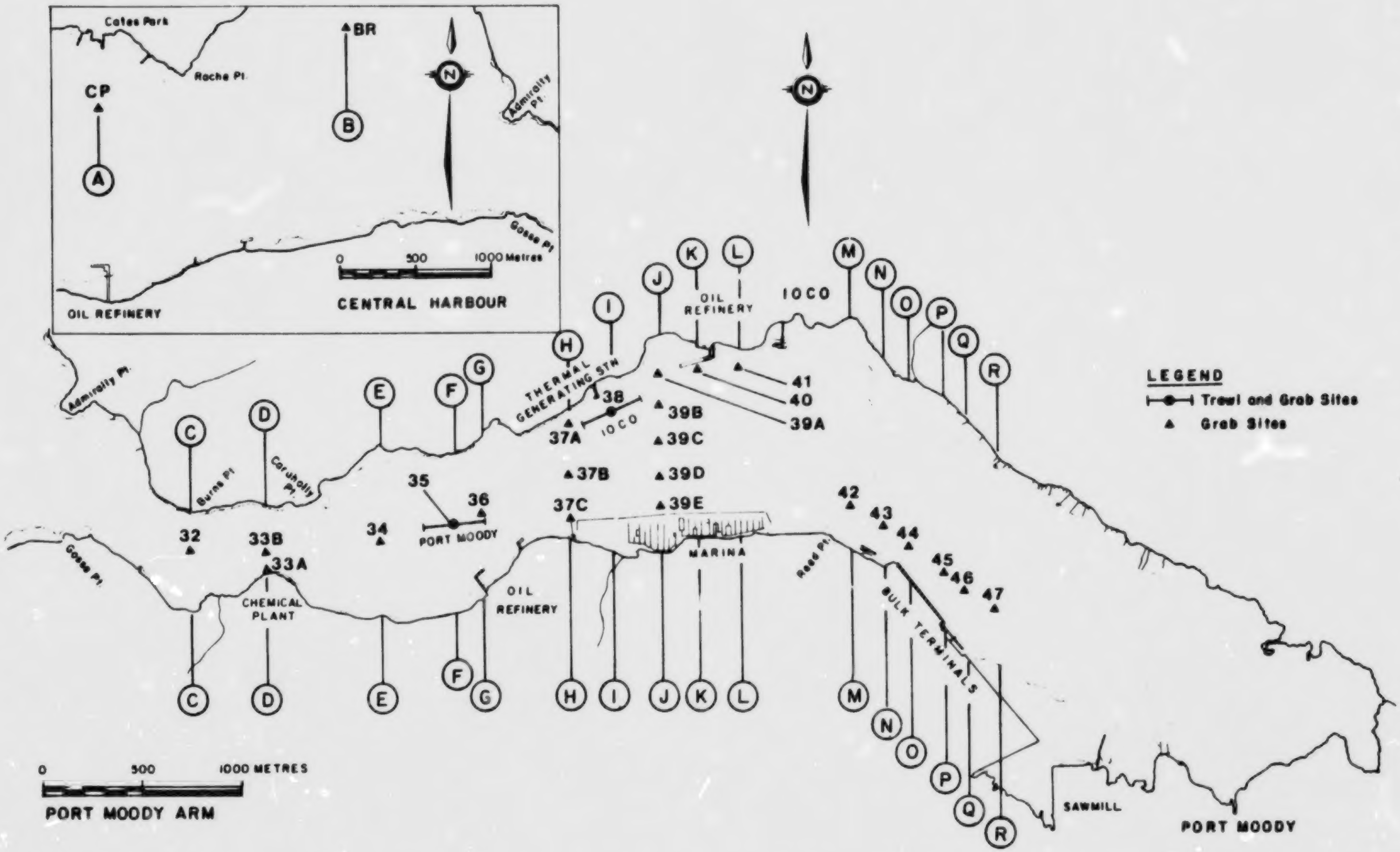
TERMINAL DOCK
CANADA PLACE
0 500 1000 METRES
INNER HARBOUR
LEGEND
Trawl and Grab Sites
▲ Grab Sites
NS No Sample (Gravel)

FIGURE 1a Sediment Sampling Stations in Vancouver Harbour (1985-86) - Outer and Inner Harbour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39B
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39D
39E
40
41
Admiralty Pt.
Burns Pt.
Caraholly Pt.
32
33B
33A
34
35
36
PORT MOODY
Goose Pt.
CHEMICAL PLANT
OIL REFINERY
MARINA
Reed Pt.
42
43
44
45
46
47
BULK TERMINALS
SAWMILL
PORT MOODY
LEGEND
Trawl and Grab Sites
Grab Sites
0
500
1000 METRES
PORT MOODY ARM

FIGURE 1b Sediment Sampling Stations in Vancouver Harbour (1985-86)-Central Harbour and Port Moody Arm

TABLE 1 VANCOUVER HARBOUR SEDIMENT SAMPLING SCHEDULE FOR SURVEYS CONDUCTED IN 1985-86 - TRACE METALS IN SEDIMENT

AREA	STN	TOTAL NO. SURVEYS	MAY 1985	OCT 1985	NOV 1985	JAN 1986	MAY 1986	JUNE 1986	SEPT 1986
OUTER HARBOUR									
	SB	1	x						
	ATK	1							x
	PEI*	5	x	x		x	x		x
	DD	1		x					
INNER HARBOUR									
North Shore	1	1						x	
	2	1						x	
	3A	1							x
	3B	1							x
	4A	1			x				
	4B	1							x
	5	1			x				
	6	1			x				
	7A	1			x				
	7B	1			x				
	8	1			x				
	9	1			x				
	10A	1			x				
	10B	1			x				
	11A	1			x				
	11B*	5	x	x		x	x		x
	12	1			x				
	13A	1			x				
	13B	1			x				
Centre	14	1							x
	15	3				x	x		x
	16*	4	x	x			x		x
South Shore	17	1							x
	18	1				x			
	19*	5	x	x		x	x		x
	20A	1						x	
	20B	1						x	
	21A	1						x	
	21B	1						x	
	21C	1						x	
	22A	1						x	
	22B	1						x	
	22C	1						x	

* corresponding otter trawl sites

TABLE 1 VANCOUVER HARBOUR SEDIMENT SAMPLING SCHEDULE FOR SURVEYS CONDUCTED IN 1985-86 - TRACE METALS IN SEDIMENT

AREA	STN	TOTAL NO. SURVEYS	MAY 1985	OCT 1985	NOV 1985	JAN 1986	MAY 1986	JUNE 1986	SEPT 1986
	23	1						x	
	24	1						x	
	25A	1						x	
	25B	1						x	
	25C	1						x	
	26	1						x	
	27	1						x	
	28	1						x	
	29	1						x	
	30	1						x	
	31	1						x	
CENTRAL HARBOUR	CP	1	x						
	BR	1	x						
EASTERN HARBOUR Pt. Moody Arm									
	32	1	x						
	33A	1	x						
	33B	1	x						
	34	1	x						
	35*	5	x	x		x	x		x
	36	1			x				
	37A	1			x				
	37B	1			x				
	37C	1			x				
	38	3				x	x		x
	39A	1			x				
	39B	1			x				
	39C	1			x				
	39D	1			x				
	39E	1			x				
	40	1			x				
	41	1			x				
	42	1	x						
	43	1	x						
	44	1	x						
	45	1	x						
	46	1	x						
	47	1	x						

* corresponding otter trawl site

2.2 Field Collection

Sediment grabs were taken with a 0.1 square metre stainless steel Smith-MacIntyre grab which provided a relatively undisturbed sample of the sediment surface. A sample from the top 2 cm was collected in a kraft paper bag, enclosed in a "whirlpak", and immediately frozen onboard the vessel. Corresponding samples were collected for: particle size; residue; and organics analyses (oil and grease, hydrocarbons, chlorophenols, polychlorinated biphenyls, polycyclic aromatic hydrocarbons). The results from these samples will be documented in subsequent reports.

Generally, three grabs were taken per station. Exceptions included single grabs at stations 27, 33A, 42-47 and two grabs at station 31. For the trawl sites, the sediment samples were taken from the centre of the trawl transect. Station coordinates and depths for each station are presented in Appendix I.

2.3 Laboratory Analysis

Frozen sediment samples were analyzed for trace metals at the EP Laboratory in West Vancouver. The samples were dried at <40°C and passed through a 100-mesh stainless steel sieve (standard series). The sediments were subsequently digested in a 3:1 nitric-hydrochloric acid mixture (partial digestion) and analyzed for aluminum (Al), arsenic (As), barium (Ba), cadmium (Cd), cobalt (Co), chromium (Cr), copper (Cu), iron (Fe), mercury (Hg), magnesium (Mg), maganese (Mn), molybdenum (Mo), nickel (Ni), lead (Pb), tin (Sn), strontium (Sr), vanadium (V), and zinc (Zn).

Most trace metals were determined using a "Jarrell Ash 975" inductively coupled plasma optical emission spectrophotometer (ICP-AES). Low-level cadmium concentrations were obtained using a "Varian 1475" atomic absorption spectrophotometer with a "Varian GTA-95" graphite furnace attachment (GF-AAS). Mercury levels were measured by cold vapour atomic absorption (CVAA) using a "Pharmacia" LCD mercury monitor with a 30 cm absorption cell. Further documentation of the analytical procedures is available from the EP laboratory; an updated manual is currently in preparation.

To evaluate the recovery efficiency of metal detection methodologies, standard marine sediment reference materials (BCSS-1 and MESS-1) from the National Research Council of Canada (NRCC) were analyzed with each set of samples submitted. Certain metals are considered more reliable by NRCC (certified) because they have been analyzed using at least two independent techniques (As, Cd, Co, Cr, Cu, Hg, Mn, Ni, Pb, V, and Zn). For each trace metal, percent recovery was determined as the EP lab result (mean) divided by the standard (BCSS-1 or MESS-1) mean times 100.

2.4 Statistical Analysis

"Multiplan" electronic spreadsheets were used to generate descriptive statistics (mean, standard deviation, coefficient of variation, maximum and minimum) from the raw data.

3.0 RESULTS AND DISCUSSION

Percent recoveries of sediment trace metals for the standard reference materials relative to the EP laboratory results are presented in Appendix IIA-F. Although recovery efficiency varied among the metals, specific metal recoveries were generally consistent for the different surveys.

A summary of mean sediment trace metal levels in Vancouver Harbour from May 1985 to September 1986 is presented in Table 2. Although 18 trace metals were analyzed, cadmium (Cd), chromium (Cr), copper (Cu), iron (Fe), mercury (Hg), nickel (Ni), lead (Pb), and zinc (Zn) have been highlighted. Figures 2 to 9 illustrate the distribution of these metals throughout the harbour. Raw data and descriptive statistics for all trace metals analyzed can be found in Appendix IIIA-G and IVA-G, respectively.

TABLE 2 MEAN SEDIMENT TRACE METAL CONCENTRATIONS OBSERVED IN VANCOUVER HARBOUR FROM 1985-86

AREA	STN	N	Concentration (μg/g) dry weight							
			Cd	Cr	Cu	Fe(%)	Hg	Ni	Pb	Zn
OUTER HARBOUR	SB	3	<0.3	50	65	3.9	.14	39	17	108
	ATK	3	0.5	57	241	3.9	.26	42	67	155
	PEI	15	0.4	58	194	4.0	.26	44	49	150
	DD	3	0.9	50	504	4.1	.26	35	67	206
INNER HARBOUR										
North Shore	1	3	5.2	39	4083	8.2	.16	296	15420	2267
	2	3	2.4	61	4353	5.5	.12	88	585	654
	3A	3	7.4	48	1187	3.3	.31	35	255	1280
	3B	3	6.6	47	1967	3.9	.18	44	262	1260
	4A	3	2.7	77	1206	3.4	-	37	162	1372
	4B	3	4.5	43	1420	3.4	.26	39	188	828
	5	3	1.5	38	542	2.9	-	19	93	1172
	6	3	0.9	53	439	3.2	-	23	97	519
	7A	3	0.6	55	307	3.0	-	22	99	483
	7B	3	0.4	42	247	3.1	-	19	72	316
	8	3	0.4	40	242	2.8	-	17	88	646
	9	3	0.5	37	226	2.9	-	16	84	382
	10A	3	0.7	47	233	3.0	-	20	73	338
	10B	3	0.5	29	146	3.0	-	13	52	172
	11A	3	0.6	33	148	2.6	-	13	70	335
	11B	15	0.6	33	226	3.3	.12	17	49	146
	12	3	0.6	50	159	3.6	-	15	77	310
	13A	3	0.6	75	143	5.0	-	13	57	256
	13B	3	0.4	39	115	3.5	-	10	39	161
Centre	14	3	0.6	33	333	2.7	.33	22	64	155
	15	9	0.7	42	396	3.3	.28	31	81	205
	16	12*	0.5	35	268	2.9	.37	24	62	161
South Shore	17	3	0.5	37	258	2.9	.31	26	76	147
	18	3	0.6	40	279	3.1	-	27	71	179
	19	15	0.6	39	271	3.1	.25	26	71	167
	20A	3	0.5	33	90	3.1	.21	20	69	131
	20B	3	0.7	33	168	2.9	.26	22	60	134
	21A	3	1.2	45	354	3.4	.30	65	144	292
	21B	3	0.9	42	336	3.3	.28	42	112	242
	21C	3	0.9	42	402	3.2	.26	34	90	224
	22A	3	1.6	37	328	3.4	.45	22	147	333
	22B	3	1.5	39	839	3.2	.31	28	120	363
	22C	3	0.7	42	859	3.2	.25	31	95	237

* N = 11 for mercury (Hg)

TABLE 2 MEAN SEDIMENT TRACE METAL CONCENTRATIONS OBSERVED IN VANCOUVER HARBOUR FROM 1985-86 (Continued)

AREA	STN	N	Concentration (µg/g) dry weight							
			Cd	Cr	Cu	Fe(%)	Hg	Ni	Pb	Zn
	23	3	1.2	40	991	2.9	.36	26	88	276
	24	3	0.9	42	452	3.0	.28	31	92	200
	25A	3	1.4	52	343	2.7	4.60	27	343	292
	25B	3	1.3	32	332	2.2	.67	25	241	248
	25C	3	0.9	43	435	3.1	.45	32	135	237
	26	3	1.1	37	543	2.8	.48	54	96	209
	27	1	1.0	44	370	3.3	.33	32	118	254
	28	3	1.4	42	434	3.1	.50	28	181	374
	29	3	1.0	35	352	2.8	.29	26	83	211
	30	3	1.1	34	418	2.6	2.20	27	116	313
	31	2	0.4	33	178	3.0	.13	15	46	113
CENTRAL HARBOUR	CP	3	<0.3	29	64	3.6	.11	7	19	88
	BR	3	0.5	30	152	2.8	.27	18	48	131
EASTERN HARBOUR Port Moody Arm	32	3	0.4	48	190	3.6	.40	25	75	165
	33A	1	<0.3	49	234	5.9	.30	22	98	243
	33B	3	0.5	48	214	5.0	.30	24	84	239
	34	3	0.4	59	180	3.9	.40	27	90	186
	35	15	0.8	71	173	4.0	.45	30	108	204
	36	3	0.9	70	193	3.7	–	28	120	202
	37A	3	1.1	96	184	3.6	–	32	140	230
	37B	3	0.4	70	172	4.0	–	28	129	204
	37C	3	0.5	66	180	4.1	–	26	128	221
	38	7*	1.1	98	149	4.1	.45	40	127	237
	39A	3	0.3	126	143	3.5	–	23	99	271
	39B	2	0.5	110	96	3.5	–	25	98	288
	39C	3	0.9	78	76	3.5	–	22	70	226
	39D	3	0.9	110	143	3.9	–	28	116	313
	39E	3	0.5	66	157	3.7	–	25	127	206
	40	3	0.6	132	99	3.6	–	26	109	388
	41	3	1.9	267	143	3.5	–	29	182	461
	42	1	3.1	64	98	3.6	.29	28	76	295
	43	1	2.0	54	78	3.3	.24	26	54	214
	44	1	2.4	60	88	3.7	.28	27	57	208
	45	1	1.8	55	79	3.5	.23	26	48	170
	46	1	1.6	49	57	3.6	.15	29	24	116
	47	1	1.5	45	48	3.5	.13	29	12	98

* N = 6 for mercury (Hg)

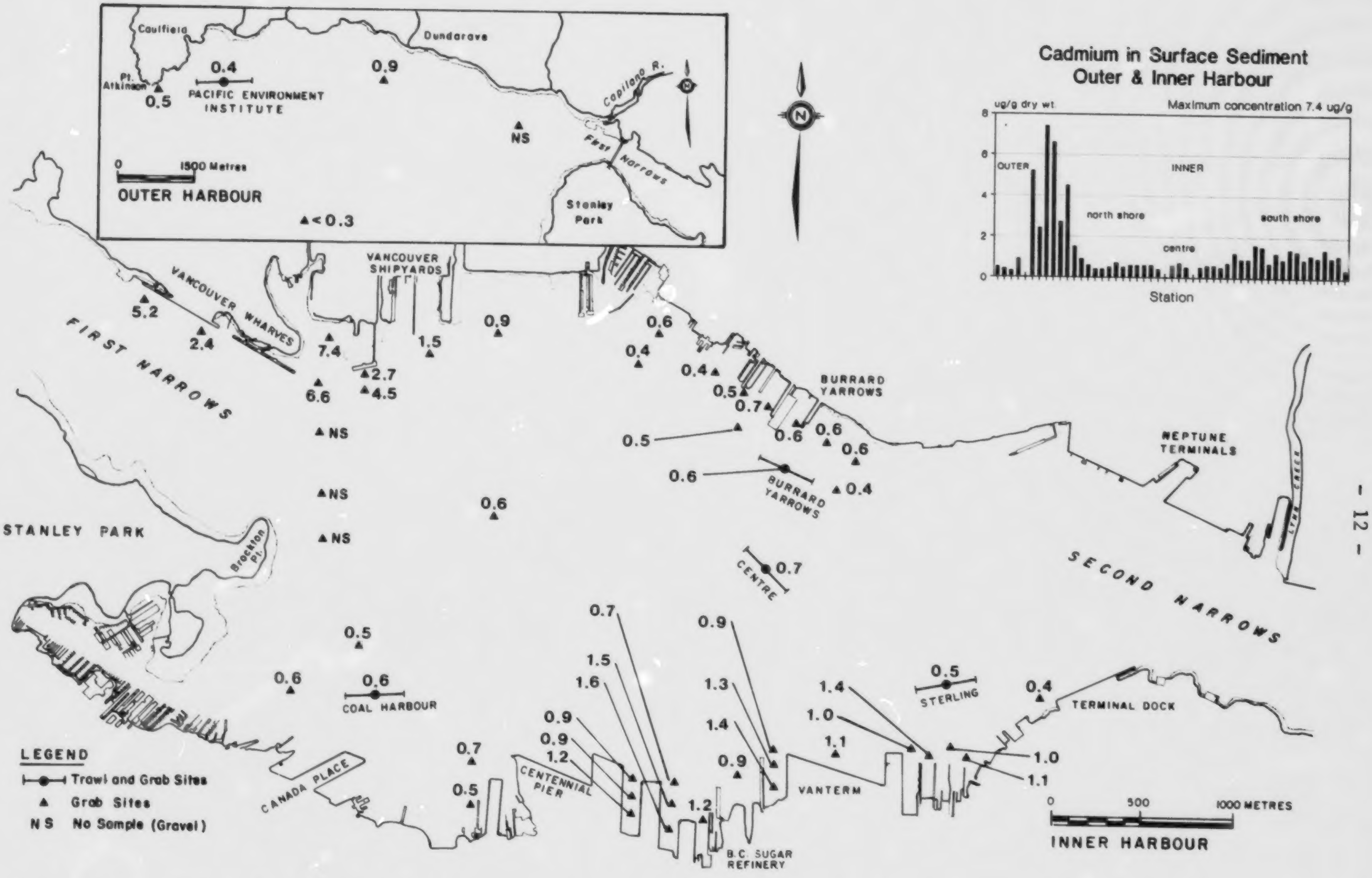
Caulfield
Pt. Atkinson
0.5
0.4
PACIFIC ENVIRONMENT INSTITUTE
Dundarave
0.9
NS
Capilano R.
First Narrows
Stanley Park
0
1500 Metres
OUTER HARBOUR
▲< 0.3
Cadmium in Surface Sediment
Outer & Inner Harbour
ug/g dry wt
Maximum concentration 7.4 ug/g
8
6
4
2
0
OUTER
INNER
north shore
centre
south shore
Station
VANCOUVER WHARVES
5.2
2.4
FIRST NARROWS
VANCOUVER SHIPYARDS
7.4
6.6
2.7
4.5
1.5
0.9
NS
NS
NS
0.6
STANLEY PARK
Brockton Pt.
0.6
0.4
0.4
0.5
0.7
0.5
0.6
0.6
0.6
0.6
0.4
BURRARD YARROWS
BURRARD YARROWS
NEPTUNE TERMINALS
LYNN CREEK
0.7
CENTRE
SECOND NARROWS
0.5
0.6
0.6
COAL HARBOUR
0.7
0.5
CANADA PLACE
CENTENNIAL PIER
0.9
0.9
1.2
1.6
1.5
0.7
1.2
B.C. SUGAR REFINERY
0.9
1.3
1.4
0.9
VANTERM
1.1
1.4
1.0
0.5
STERLING
1.0
1.1
0.4
TERMINAL DOCK
0
500
1000 METRES
INNER HARBOUR
LEGEND
Trawl and Grab Sites
▲ Grab Sites
NS No Sample (Gravel)

FIGURE 2a Mean Surface Sediment Cadmium Concentrations in µg/g Dry Weight (1985-86) Outer and Inner Harbour

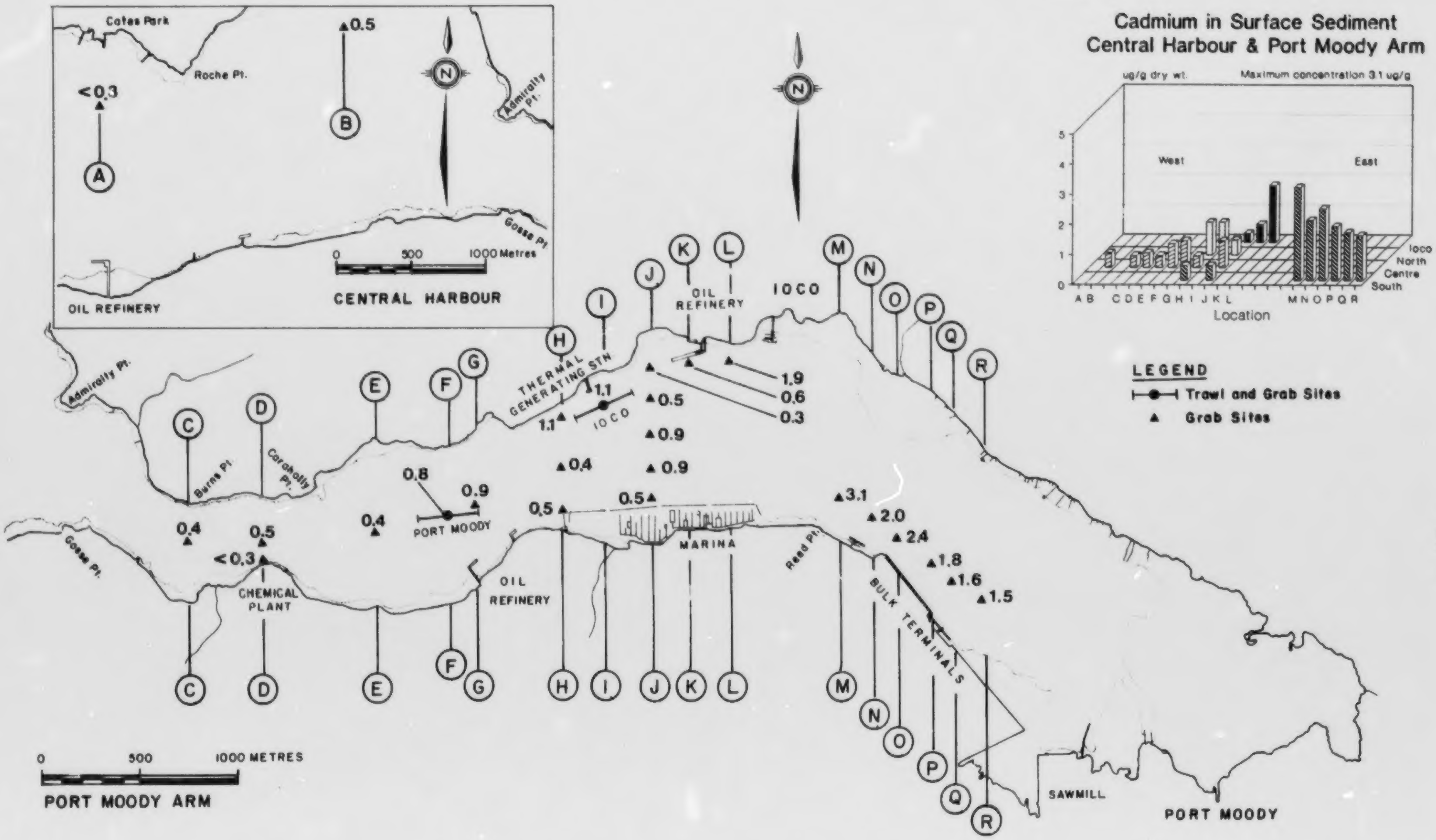
Cotes Park
Roche Pt.
<0.3
0.5
A
B
N
Admiralty Pt.
Gosse Pt.
OIL REFINERY
0
500
1000 Metres
CENTRAL HARBOUR
Cadmium in Surface Sediment
Central Harbour & Port Moody Arm
ug/g dry wt.
Maximum concentration 3.1 ug/g
West
East
0
1
2
3
4
5
A B C D E F G H I J K L M N O P Q R
Location
Ioco
North
Centre
South
LEGEND
Trawl and Grab Sites
Grab Sites
Admiralty Pt.
Burns Pt.
Carraholly Pt.
THERMAL GENERATING STN
IOCO
OIL REFINERY
IOCO
1.9
0.6
0.3
0.5
0.9
0.9
1.1
1.1
0.4
0.8
0.9
PORT MOODY
0.5
0.5
0.4
0.4
0.5
<0.3
CHEMICAL PLANT
Gosse Pt.
OIL REFINERY
MARINA
Reed Pt.
3.1
2.0
2.4
1.8
1.6
1.5
BULK TERMINALS
SAWMILL
PORT MOODY
C D E F G H I J K L M N O P Q R
0
500
1000 METRES
PORT MOODY ARM

FIGURE 2b Mean Surface Sediment Cadmium Concentrations in μg/g Dry Weight (1985-86) - Central Harbour and Port Moody Arm

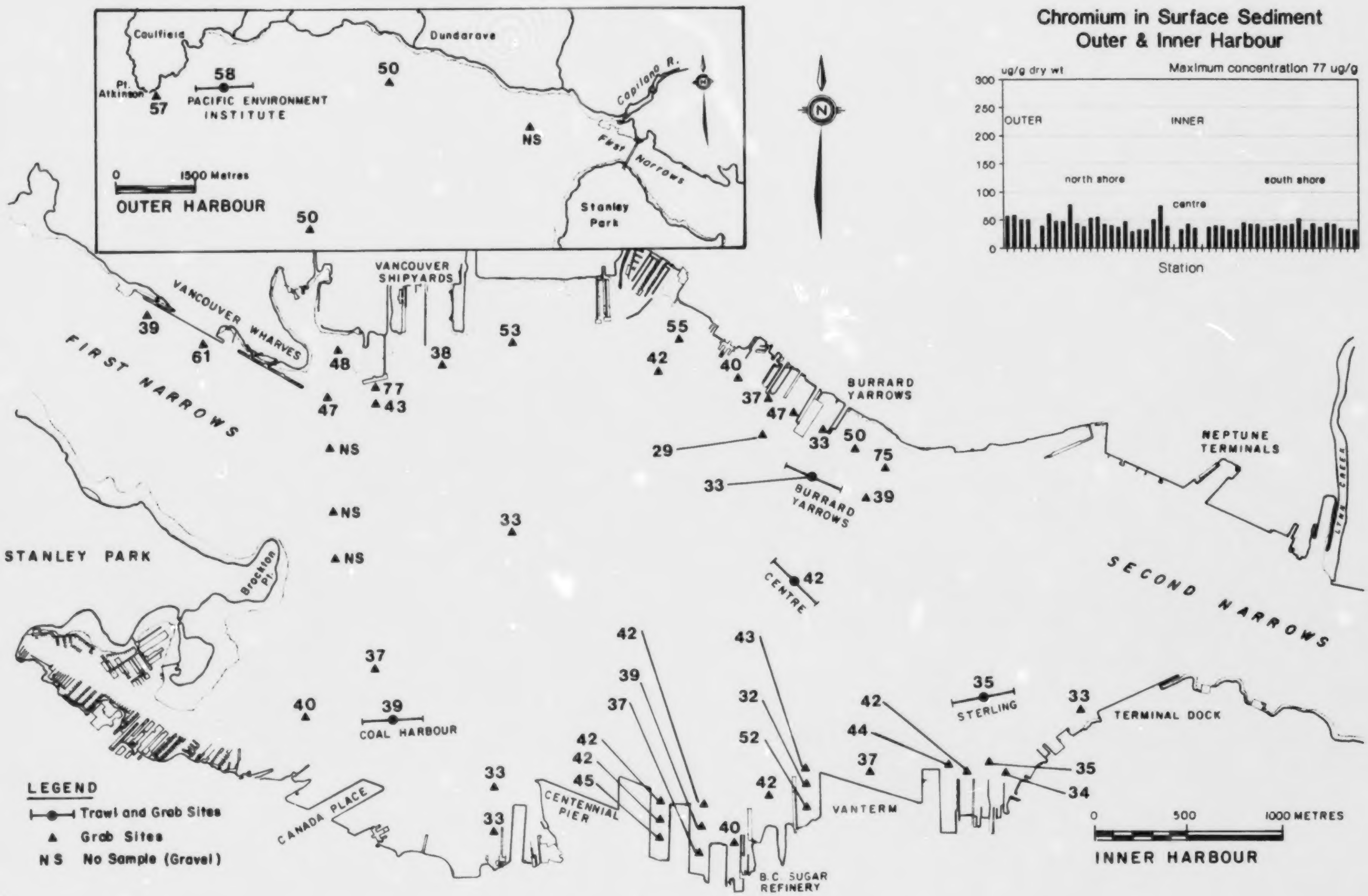
Chromium in Surface Sediment
Outer & Inner Harbour
ug/g dry wt
Maximum concentration 77 ug/g
300
250
200
150
100
50
0
OUTER
INNER
north shore
centre
south shore
Station
Caulfield
Dundarave
Pt. Atkinson
57
58
PACIFIC ENVIRONMENT INSTITUTE
50
NS
Capilano R.
First Narrows
Stanley Park
0
1500 Metres
OUTER HARBOUR
50
VANCOUVER WHARVES
39
61
FIRST NARROWS
VANCOUVER SHIPYARDS
48
47
77
43
38
53
55
42
40
37
47
BURRARD YARROWS
33
50
75
29
33
BURRARD YARROWS
39
NEPTUNE TERMINALS
LYNN CREEK
NS
NS
NS
33
STANLEY PARK
Brockton Pt.
CENTRE
42
SECOND NARROWS
37
40
39
COAL HARBOUR
42
39
37
42
42
45
43
32
52
42
33
33
CENTENNIAL PIER
40
B.C. SUGAR REFINERY
VANTERM
37
42
44
35
STERLING
33
TERMINAL DOCK
35
34
CANADA PLACE
0
500
1000 METRES
INNER HARBOUR
LEGEND
Trawl and Grab Sites
Grab Sites
NS No Sample (Gravel)

FIGURE 3a Mean Surface Sediment Chromium Concentrations in µg/g Dry Weight (1985-86)- Outer and Inner Harbour

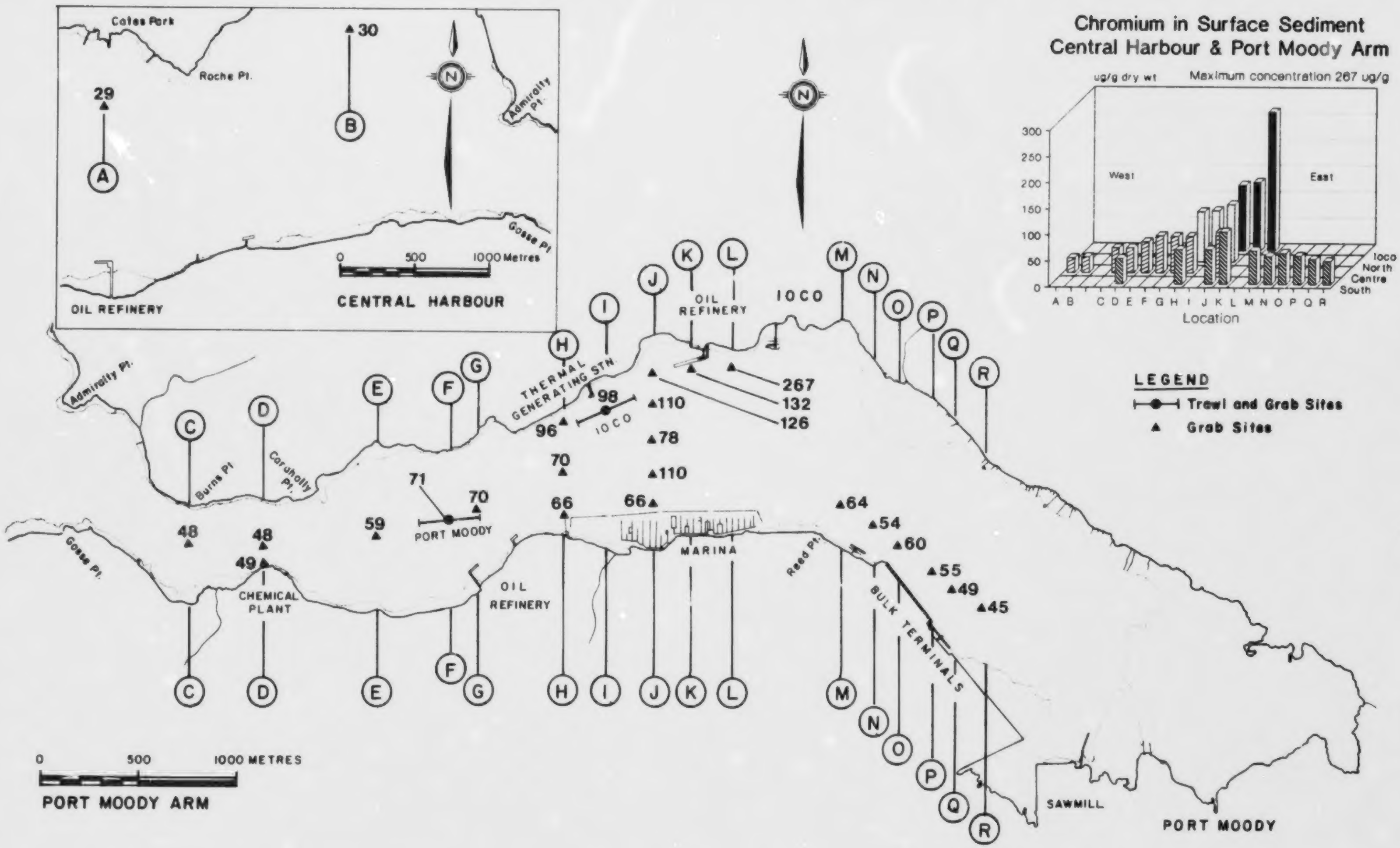
Coles Park
Roche Pt.
Admiralty Pt.
Gosse Pt.
29
A
30
B
N
0
500
1000 Metres
OIL REFINERY
CENTRAL HARBOUR
Chromium in Surface Sediment
Central Harbour & Port Moody Arm
ug/g dry wt
Maximum concentration 267 ug/g
300
250
200
150
100
50
0
West
East
A B C D E F G H I J K L M N O P Q R
Location
Ioco
North
Centre
South
LEGEND
Trawl and Grab Sites
Grab Sites
Admiralty Pt.
Burns Pt.
Caruholly Pt.
Gosse Pt.
C
D
E
F
G
H
I
J
K
L
M
N
O
P
Q
R
THERMAL GENERATING STN.
OIL REFINERY
IOCO
267
132
126
98
96
110
78
70
110
66
66
71
70
PORT MOODY
59
48
48
49
64
54
60
55
49
45
CHEMICAL PLANT
OIL REFINERY
MARINA
Reed Pt.
BULK TERMINALS
SAWMILL
PORT MOODY
0
500
1000 METRES
PORT MOODY ARM

FIGURE 3b Mean Surface Sediment Chromium Concentrations in ug/g Dry Weight (1985-86)
Central Harbour and Port Moody Arm

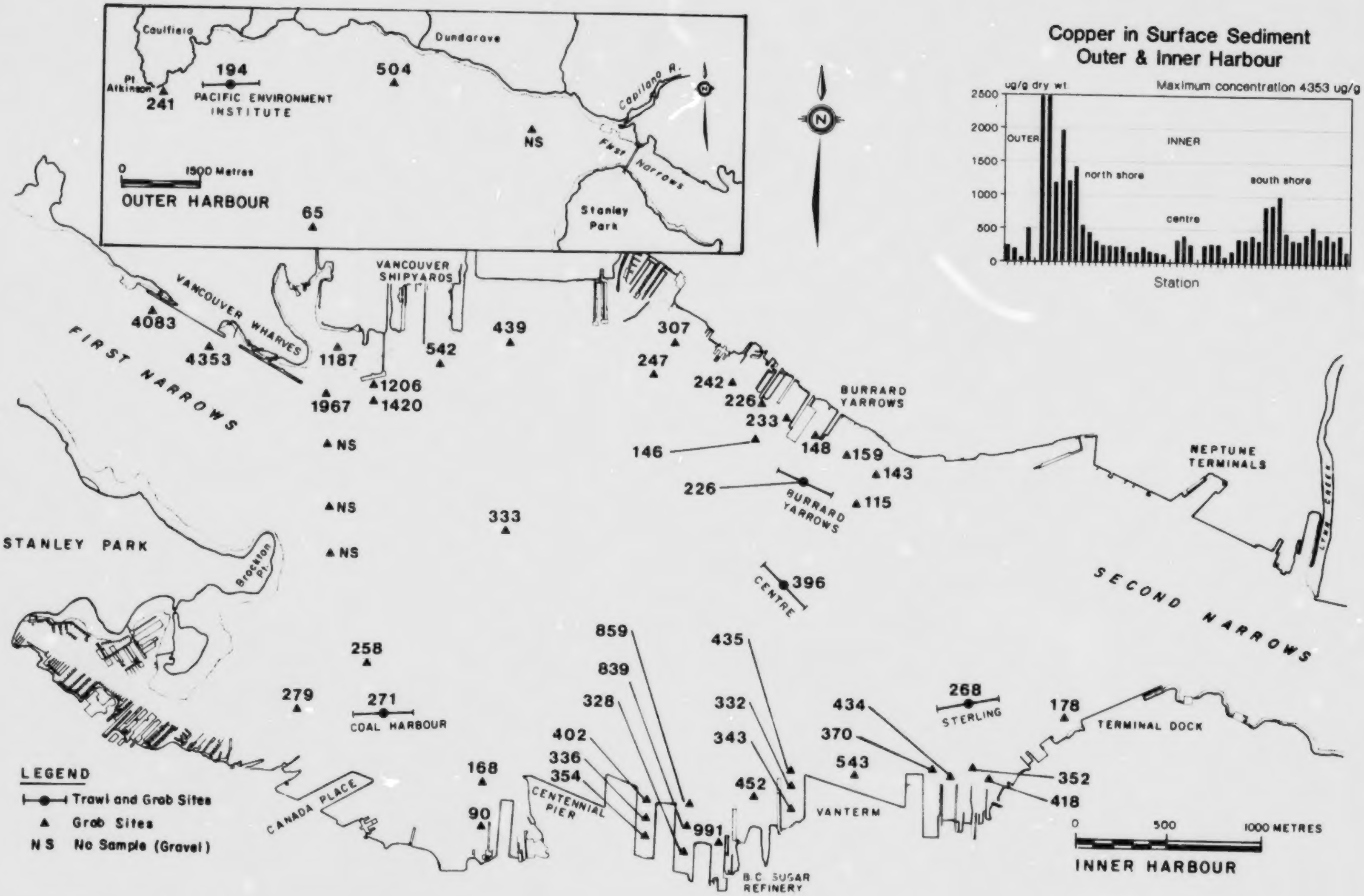
Copper in Surface Sediment
Outer & Inner Harbour
ug/g dry wt
Maximum concentration 4353 ug/g
2500
2000
1500
1000
500
0
OUTER
INNER
north shore
centre
south shore
Station
Caulfield
Pt Atkinson
241
194
PACIFIC ENVIRONMENT INSTITUTE
504
Dundarave
Capilano R.
First Narrows
NS
Stanley Park
0
1500 Metres
OUTER HARBOUR
65
N
VANCOUVER WHARVES
4083
4353
FIRST NARROWS
VANCOUVER SHIPYARDS
1187
1206
1420
1967
542
439
NS
NS
NS
STANLEY PARK
Brockton Pt.
333
307
247
242
226
233
BURRARD YARROWS
146
148
159
143
226
BURRARD YARROWS
115
NEPTUNE TERMINALS
LYNN CREEK
396
CENTRE
SECOND NARROWS
258
279
271
COAL HARBOUR
LEGEND
Trawl and Grab Sites
Grab Sites
NS No Sample (Gravel)
CANADA PLACE
168
90
CENTENNIAL PIER
859
839
328
402
336
354
991
435
332
343
452
B.C. SUGAR REFINERY
VANTERM
543
434
370
268
STERLING
178
TERMINAL DOCK
352
418
0
500
1000 METRES
INNER HARBOUR

FIGURE 4a Mean Surface Sediment Copper Concentrations in µg/g Dry Weight (1985-86)- Outer and Inner Harbour

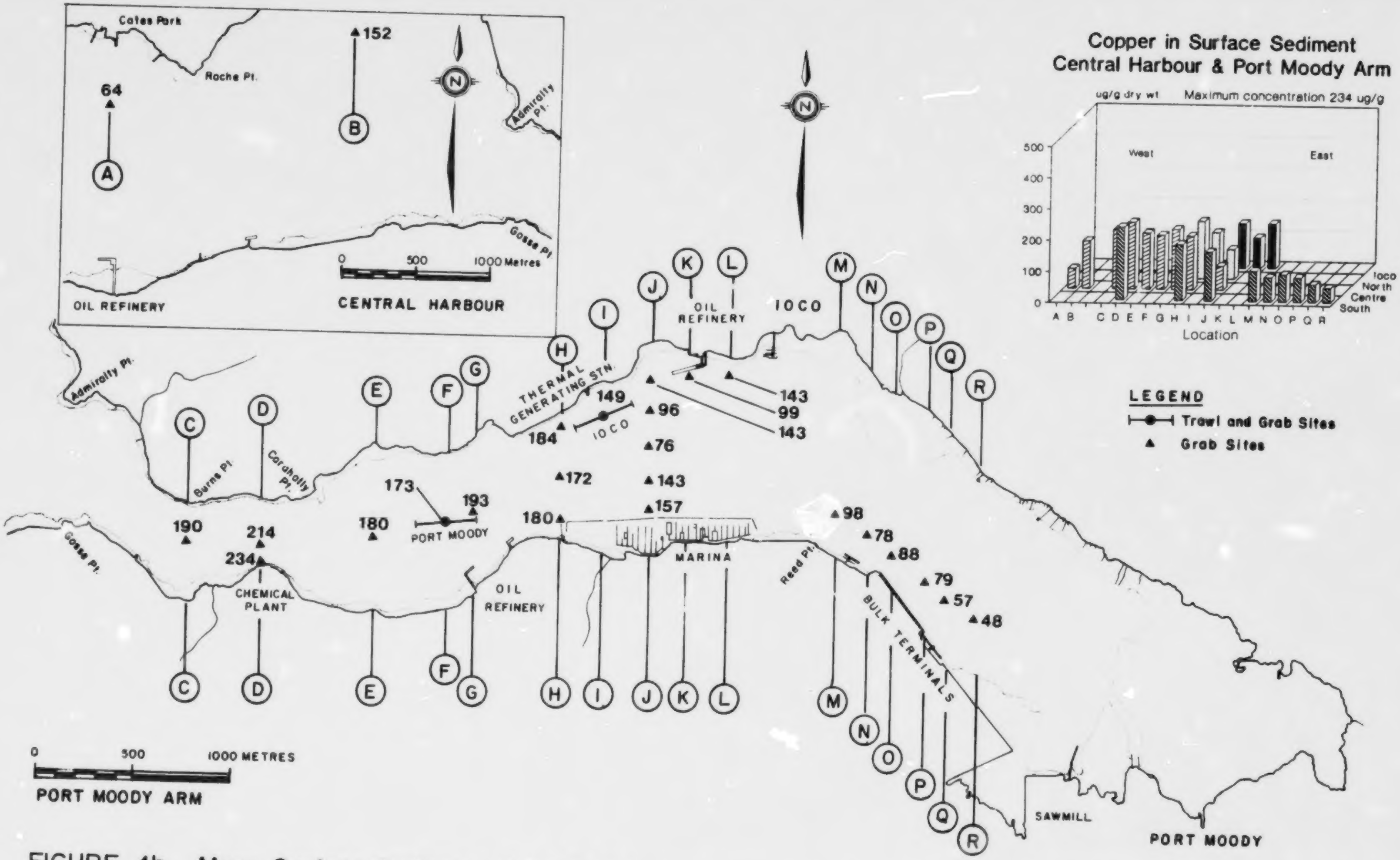
Cates Park
Roche Pt.
Admiralty Pt.
Gosse Pt.
64
152
A
B
N
OIL REFINERY
0 500 1000 Metres
CENTRAL HARBOUR
Copper in Surface Sediment
Central Harbour & Port Moody Arm
ug/g dry wt
Maximum concentration 234 ug/g
500
400
300
200
100
0
West
East
A B C D E F G H I J K L M N O P Q R
Location
Ioco
North
Centre
South
LEGEND
Trawl and Grab Sites
Grab Sites
Admiralty Pt.
Burns Pt.
Caraholly Pt.
THERMAL GENERATING STN.
OIL REFINERY
IOCO
Gosse Pt.
CHEMICAL PLANT
PORT MOODY
OIL REFINERY
MARINA
Reed Pt.
BULK TERMINALS
SAWMILL
PORT MOODY
190
214
234
180
173
193
184
149
172
180
96
76
143
157
143
99
143
98
78
88
79
57
48
C D E F G H I J K L M N O P Q R
0 500 1000 METRES
PORT MOODY ARM

FIGURE 4b Mean Surface Sediment Copper Concentrations in µg/g Dry Weight (1985-86) - Central Harbour and Port Moody Arm.

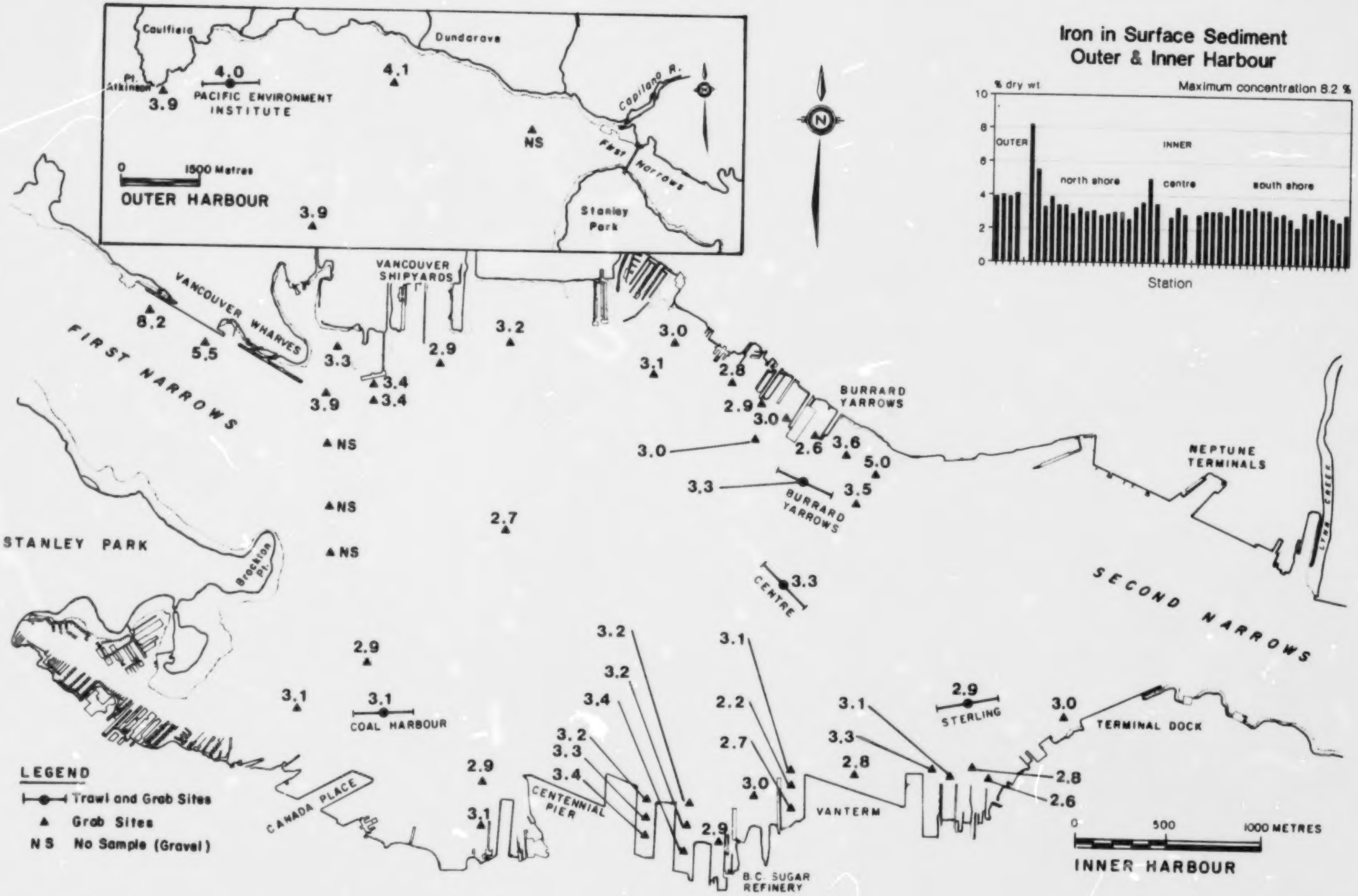
Iron in Surface Sediment
Outer & Inner Harbour
% dry wt
Maximum concentration 8.2 %
10
8
6
4
2
0
OUTER
INNER
north shore
centre
south shore
Station
Caulfield
Pt. Atkinson
3.9
4.0
PACIFIC ENVIRONMENT INSTITUTE
Dundarave
4.1
NS
Capilano R.
First Narrows
Stanley Park
0
1500 Metres
OUTER HARBOUR
3.9
N
VANCOUVER SHIPYARDS
VANCOUVER WHARVES
8.2
5.5
FIRST NARROWS
3.3
3.9
3.4
3.4
2.9
3.2
3.0
3.1
2.8
2.9
3.0
BURRARD YARROWS
3.0
2.6
3.6
5.0
3.3
BURRARD YARROWS
3.5
NEPTUNE TERMINALS
LYNN CREEK
NS
NS
NS
2.7
STANLEY PARK
Brockton Pt.
3.3
CENTRE
SECOND NARROWS
2.9
3.1
3.1
COAL HARBOUR
2.9
3.1
CANADA PLACE
3.2
3.2
3.4
3.2
3.3
3.4
CENTENNIAL PIER
2.9
B.C. SUGAR REFINERY
3.1
2.2
2.7
3.0
VANTERM
3.1
3.3
2.8
2.9
STERLING
3.0
TERMINAL DOCK
2.8
2.6
0
500
1000 METRES
INNER HARBOUR
LEGEND
Trawl and Grab Sites
▲ Grab Sites
NS No Sample (Gravel)

FIGURE 5a Mean Surface Sediment Iron Concentrations by Per Cent Dry Weight (1985-86)- Outer and Inner Harbour

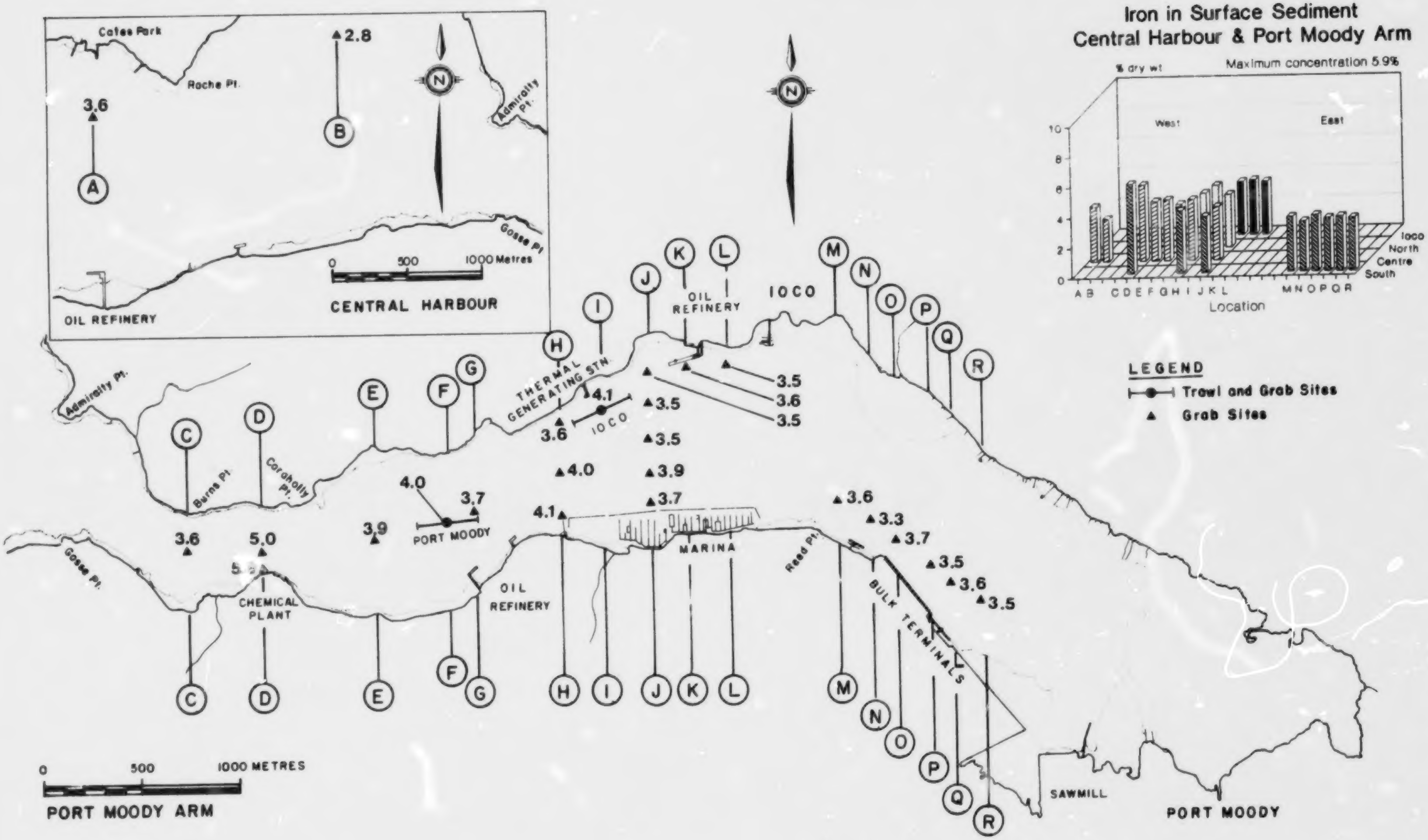
Iron in Surface Sediment
Central Harbour & Port Moody Arm
% dry wt
Maximum concentration 5.9%
West
East
10
8
6
4
2
0
A B C D E F G H I J K L M N O P Q R
Location
Ioco
North
Centre
South
LEGEND
Trawl and Grab Sites
Grab Sites
Cates Park
Roche Pt.
Admiralty Pt.
Gosse Pt.
OIL REFINERY
CENTRAL HARBOUR
0
500
1000 Metres
A
3.6
B
2.8
N
C
D
E
F
G
H
I
J
K
L
M
N
O
P
Q
R
Burns Pt.
Caraholly Pt.
THERMAL GENERATING STN.
IOCO
OIL REFINERY
PORT MOODY
CHEMICAL PLANT
MARINA
Reed Pt.
BULK TERMINALS
SAWMILL
3.6
5.0
5.2
3.9
4.0
3.7
4.1
4.1
3.6
4.0
3.5
3.5
3.9
3.7
3.5
3.6
3.5
3.6
3.3
3.7
3.5
3.6
3.5
0
500
1000 METRES
PORT MOODY ARM

FIGURE 5b Mean Surface Sediment Iron Concentrations by Per Cent Dry Weight (1985-86) - Central Harbour and Port Moody Arm

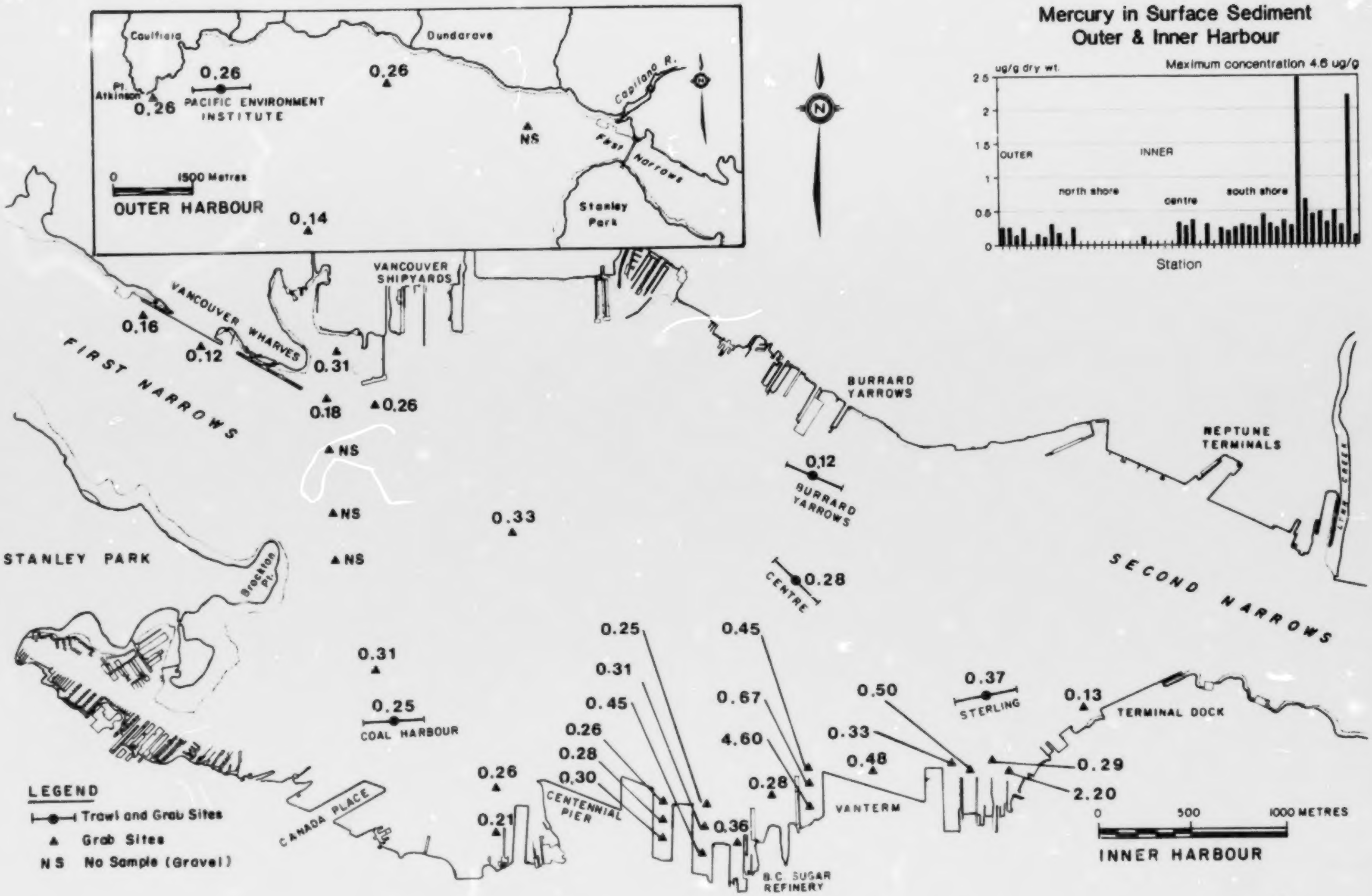
Mercury in Surface Sediment
Outer & Inner Harbour
ug/g dry wt.
Maximum concentration 4.6 ug/g
2.5
2
1.5
1
0.5
0
OUTER
INNER
north shore
centre
south shore
Station
Caulfield
Pt. Atkinson
0.26
0.26
PACIFIC ENVIRONMENT INSTITUTE
Dundarave
0.26
NS
Capilano R.
First Narrows
Stanley Park
0
1500 Metres
OUTER HARBOUR
0.14
N
N
VANCOUVER SHIPYARDS
VANCOUVER WHARVES
0.16
0.12
0.31
0.18
0.26
FIRST NARROWS
NS
NS
NS
0.33
STANLEY PARK
Brockton Pt.
BURRARD YARROWS
0.12
BURRARD YARROWS
NEPTUNE TERMINALS
0.28
CENTRE
SECOND NARROWS
0.31
0.25
COAL HARBOUR
0.26
0.21
CANADA PLACE
CENTENNIAL PIER
0.25
0.31
0.45
0.26
0.28
0.30
0.36
0.45
0.67
4.60
0.28
B.C. SUGAR REFINERY
VANTERM
0.50
0.33
0.48
0.37
STERLING
0.13
TERMINAL DOCK
0.29
2.20
0
500
1000 METRES
INNER HARBOUR
LEGEND
Trawl and Grab Sites
▲ Grab Sites
NS No Sample (Gravel)

FIGURE 6a Mean Surface Sediment Mercury Concentrations in µg/g Dry Weight (1985-86) - Outer and Inner Harbour

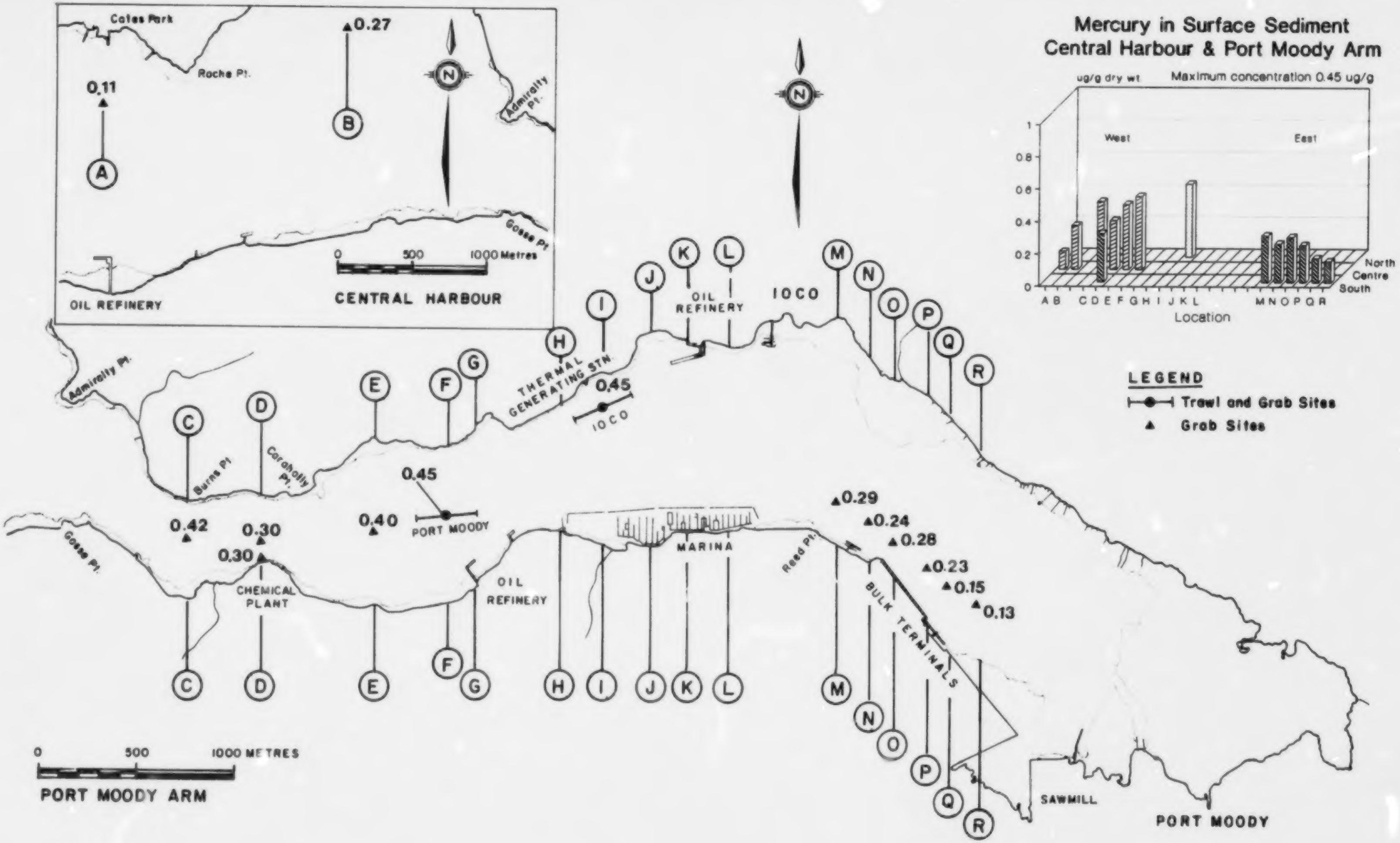
Cotes Park
Roche Pt.
Admiralty Pt.
Gosse Pt.
0.11
0.27
A
B
N
OIL REFINERY
0 500 1000 Metres
CENTRAL HARBOUR
Mercury in Surface Sediment
Central Harbour & Port Moody Arm
ug/g dry wt
Maximum concentration 0.45 ug/g
1
0.8
0.6
0.4
0.2
0
West
East
North
Centre
South
A B C D E F G H I J K L M N O P Q R
Location
LEGEND
Trawl and Grab Sites
Grab Sites
THERMAL GENERATING STN.
0.45
IOCO
OIL REFINERY
IOCO
Burns Pt.
Carraholly Pt.
0.45
PORT MOODY
0.42
0.30
0.30
0.40
CHEMICAL PLANT
OIL REFINERY
MARINA
Reed Pt.
0.29
0.24
0.28
0.23
0.15
0.13
BULK TERMINALS
SAWMILL
PORT MOODY
C D E F G H I J K L M N O P Q R
0 500 1000 METRES
PORT MOODY ARM

FIGURE 6b Mean Surface Sediment Mercury Concentrations in µg/g Dry Weight (1985-86)- Central Harbour and Port Moody Arm

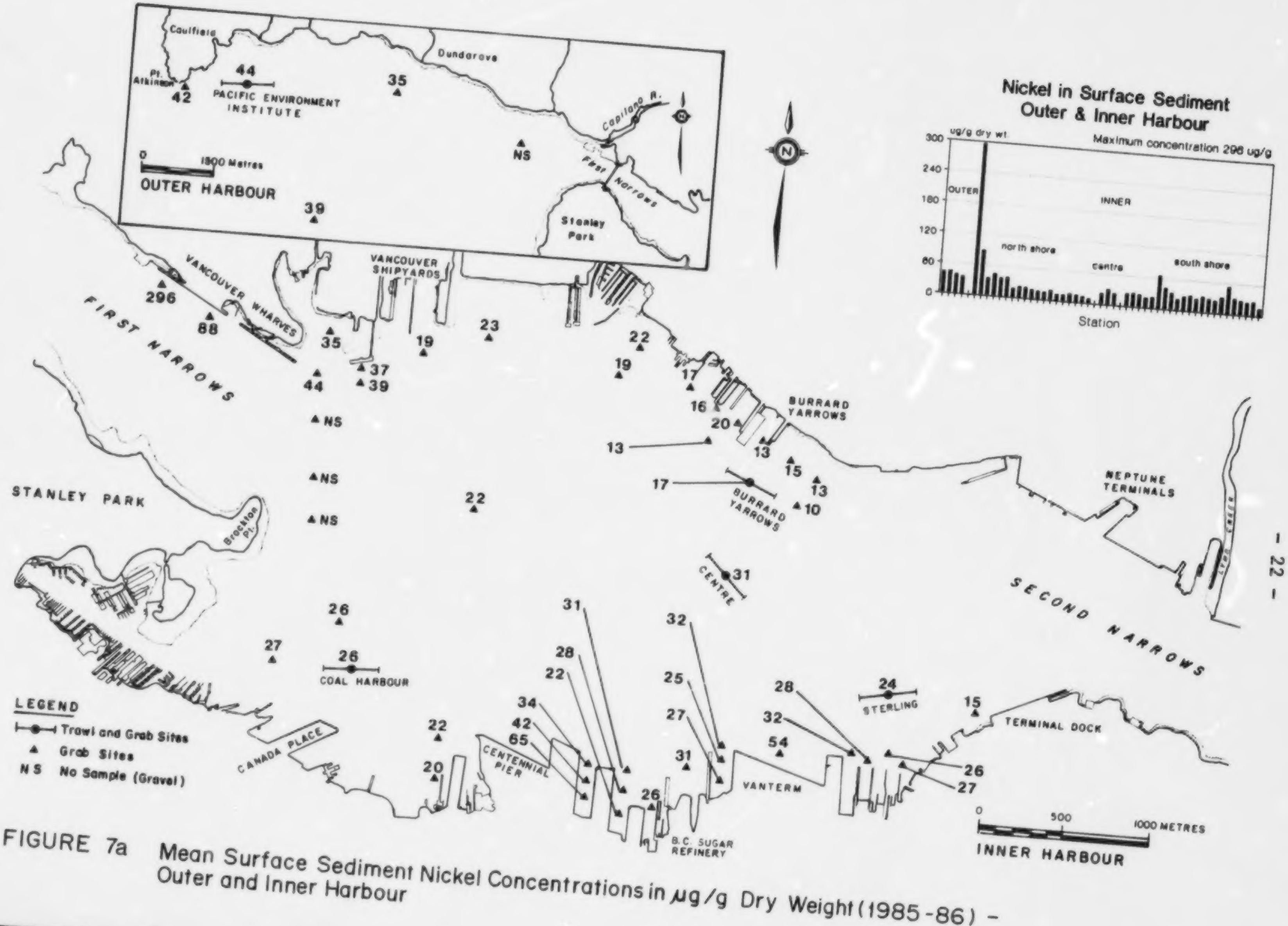
Nickel in Surface Sediment
Outer & Inner Harbour
ug/g dry wt
Maximum concentration 296 ug/g
300
240
180
120
60
0
OUTER
INNER
north shore
centre
south shore
Station
Caulfield
Pt. Atkinson
42
44
PACIFIC ENVIRONMENT INSTITUTE
35
Dundarave
Capilano R.
NS
First Narrows
Stanley Park
0
1800 Metres
OUTER HARBOUR
39
N
296
88
VANCOUVER WHARVES
FIRST NARROWS
35
VANCOUVER SHIPYARDS
19
23
37
39
44
NS
NS
NS
22
19
22
17
16
20
13
13
BURRARD YARROWS
15
13
17
BURRARD YARROWS
10
NEPTUNE TERMINALS
STANLEY PARK
Brockton Pt.
31
CENTRE
SECOND NARROWS
26
27
26
COAL HARBOUR
31
28
22
32
25
27
28
32
24
STERLING
15
TERMINAL DOCK
34
42
65
CENTENNIAL PIER
22
20
CANADA PLACE
31
54
26
27
26
VANTERM
B.C. SUGAR REFINERY
0
500
1000 METRES
INNER HARBOUR
LEGEND
Trawl and Grab Sites
▲ Grab Sites
NS No Sample (Gravel)

FIGURE 7a Mean Surface Sediment Nickel Concentrations in $\mu g/g$ Dry Weight (1985-86) - Outer and Inner Harbour

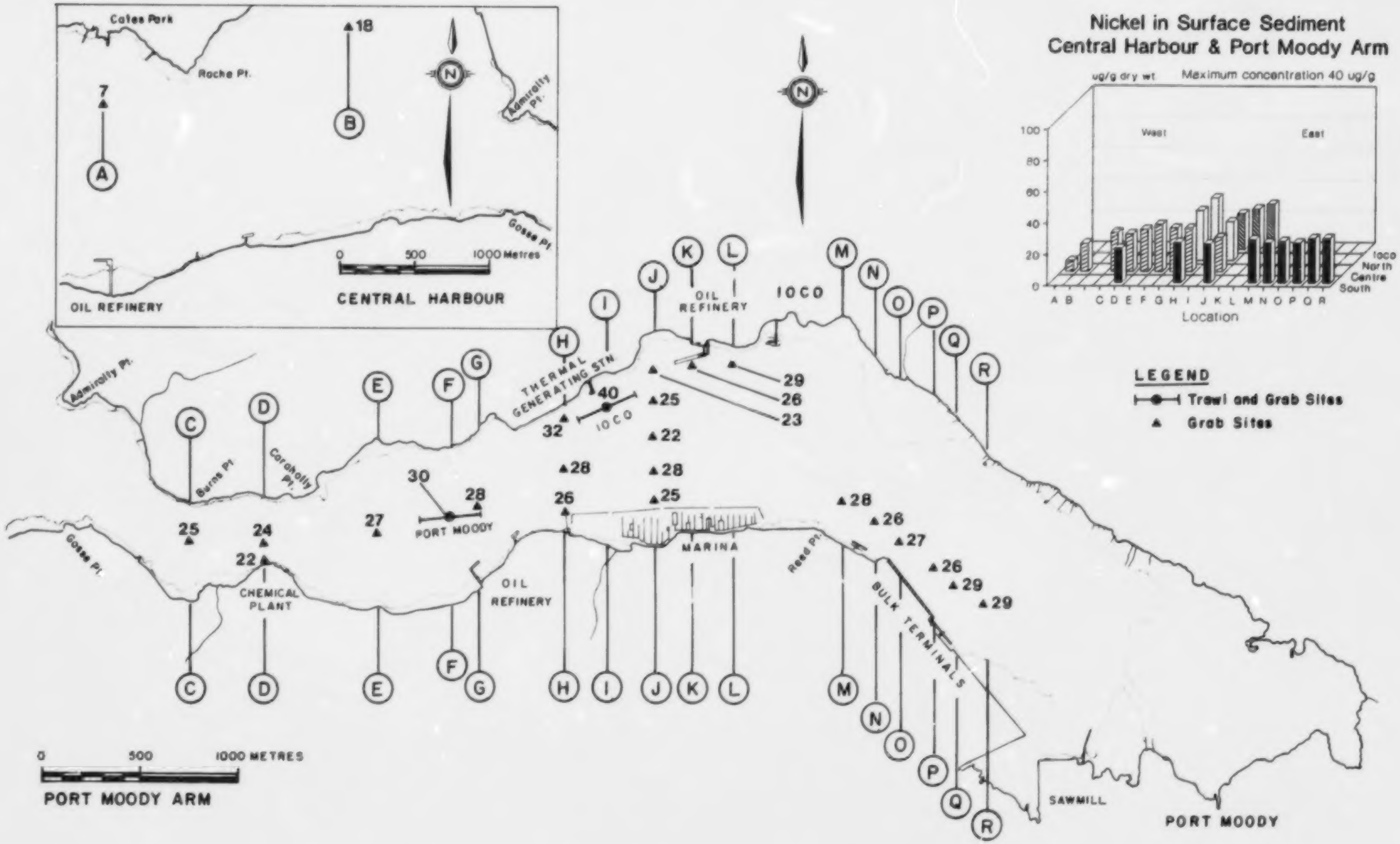
Cates Park
Roche Pt.
Admiralty Pt.
Gosse Pt.
OIL REFINERY
▲18
7 ▲
A
B
N
0
500
1000 Metres
CENTRAL HARBOUR
Nickel in Surface Sediment
Central Harbour & Port Moody Arm
ug/g dry wt
Maximum concentration 40 ug/g
West
East
100
80
60
40
20
0
A B C D E F G H I J K L M N O P Q R
Location
Ioco
North
Centre
South
LEGEND
Trawl and Grab Sites
Grab Sites
Admiralty Pt.
Burns Pt.
Caraholly Pt.
Gosse Pt.
THERMAL GENERATING STN
IOCO
OIL REFINERY
IOCO
MARINA
Reed Pt.
BULK TERMINALS
CHEMICAL PLANT
OIL REFINERY
PORT MOODY
SAWMILL
PORT MOODY
25
24
22
27
30
28
32
40
28
26
25
22
28
25
29
26
23
28
26
27
26
29
29
C
D
E
F
G
H
I
J
K
L
M
N
O
P
Q
R
0
500
1000 METRES
PORT MOODY ARM

FIGURE 7b Mean Surface Sediment Nickel Concentrations in µg/g Dry Weight (1985-86)- Central Harbour and Port Moody Arm

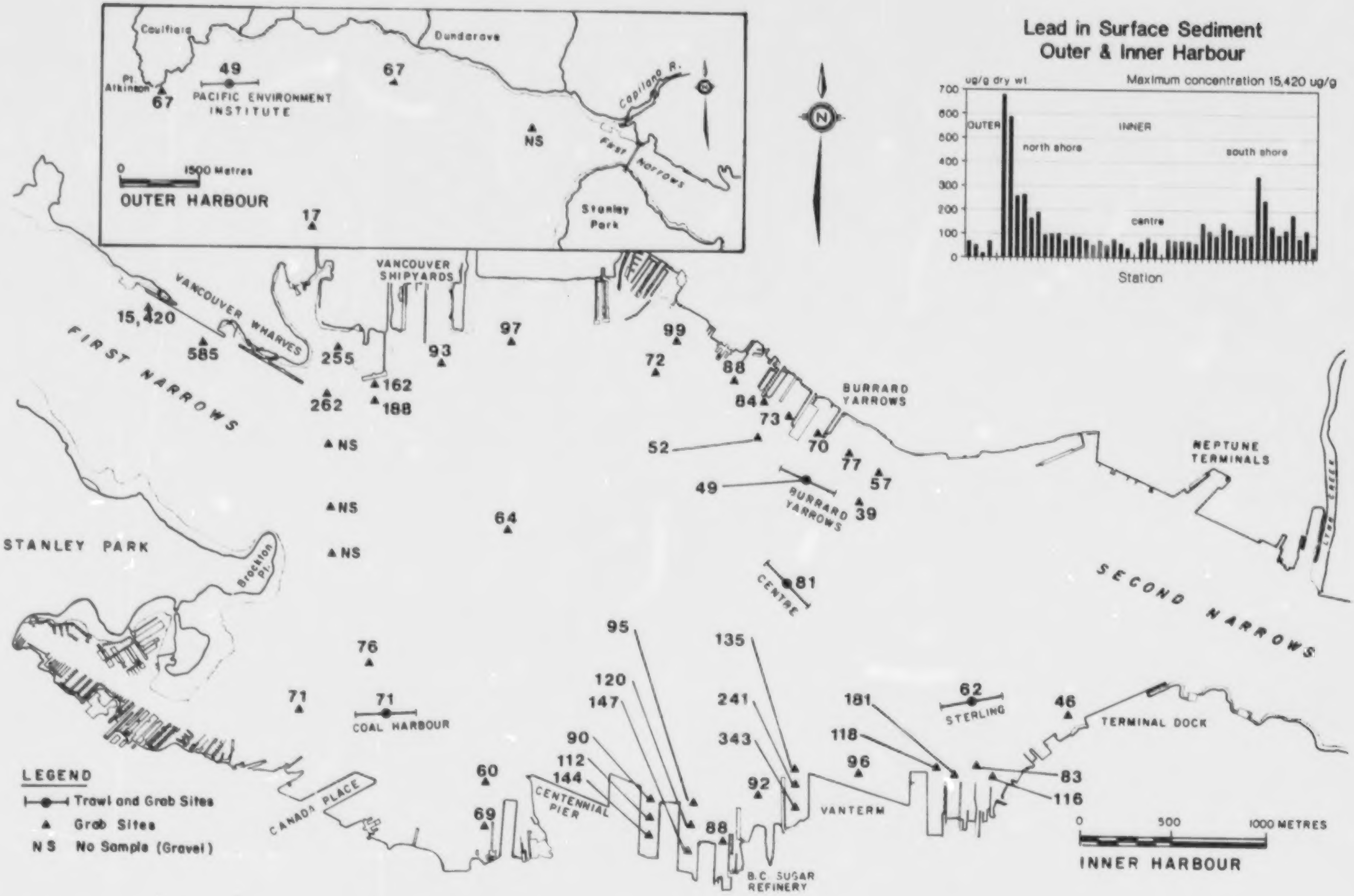
Lead in Surface Sediment
Outer & Inner Harbour
ug/g dry wt
Maximum concentration 15,420 ug/g
700
600
500
400
300
200
100
0
OUTER
INNER
north shore
centre
south shore
Station
Coulfield
Dundarave
Pt. Atkinson
67
49
PACIFIC ENVIRONMENT INSTITUTE
67
NS
Capilano R.
First Narrows
Stanley Park
0
1500 Metres
OUTER HARBOUR
17
15,420
585
VANCOUVER WHARVES
FIRST NARROWS
255
262
VANCOUVER SHIPYARDS
162
188
93
97
NS
NS
NS
64
99
72
88
84
73
BURRARD YARROWS
52
70
77
57
49
BURRARD YARROWS
39
NEPTUNE TERMINALS
LYNN CREEK
81
CENTRE
SECOND NARROWS
STANLEY PARK
Brockton Pt.
76
71
71
COAL HARBOUR
60
69
CANADA PLACE
CENTENNIAL PIER
95
120
147
90
112
144
88
135
241
343
92
B.C. SUGAR REFINERY
VANTERM
181
118
96
62
STERLING
46
83
116
TERMINAL DOCK
0
500
1000 METRES
INNER HARBOUR
LEGEND
Trawl and Grab Sites
Grab Sites
NS No Sample (Gravel)

FIGURE 8a Mean Surface Sediment Lead Concentrations in µg/g Dry Weight (1985-86) - Outer and Inner Harbour

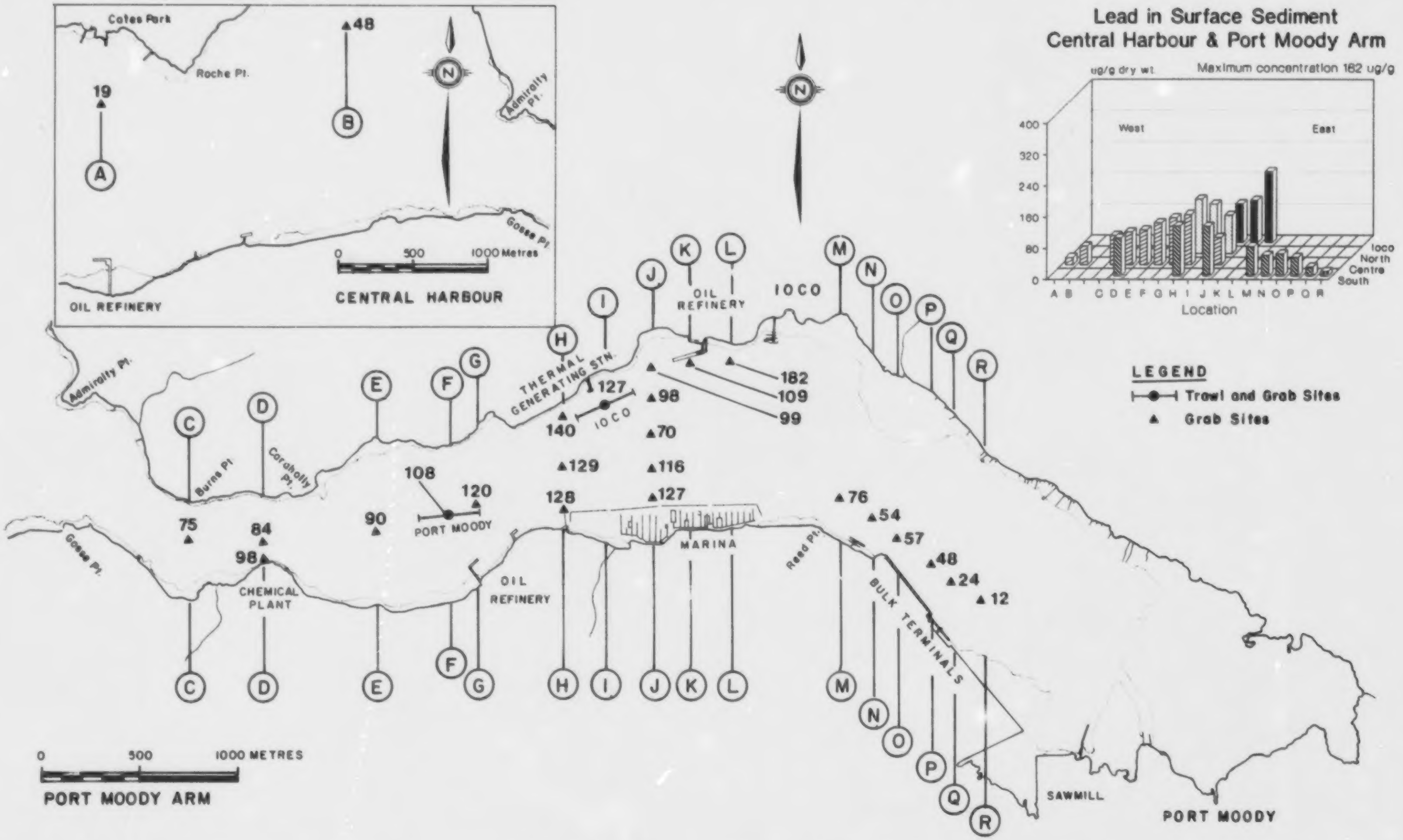
Cates Park
Roche Pt.
Admiralty Pt.
Gosse Pt.
19
A
48
B
N
0 500 1000 Metres
OIL REFINERY
CENTRAL HARBOUR
Lead in Surface Sediment
Central Harbour & Port Moody Arm
ug/g dry wt.
Maximum concentration 182 ug/g
400
320
240
160
80
0
West
East
A B C D E F G H I J K L M N O P Q R
Location
Ioco
North
Centre
South
LEGEND
Trawl and Grab Sites
Grab Sites
Admiralty Pt.
Burns Pt.
Caraholly Pt.
Gosse Pt.
Reed Pt.
THERMAL GENERATING STN.
IOCO
OIL REFINERY
MARINA
CHEMICAL PLANT
BULK TERMINALS
SAWMILL
PORT MOODY
C
D
E
F
G
H
I
J
K
L
M
N
O
P
Q
R
75
84
98
90
108
120
PORT MOODY
140
127
IOCO
129
128
98
70
116
127
182
109
99
76
54
57
48
24
12
0 500 1000 METRES
PORT MOODY ARM

FIGURE 8b Mean Surface Sediment Lead Concentrations in µg/g Dry Weight (1985-86) Central Harbour and Port Moody Arm.

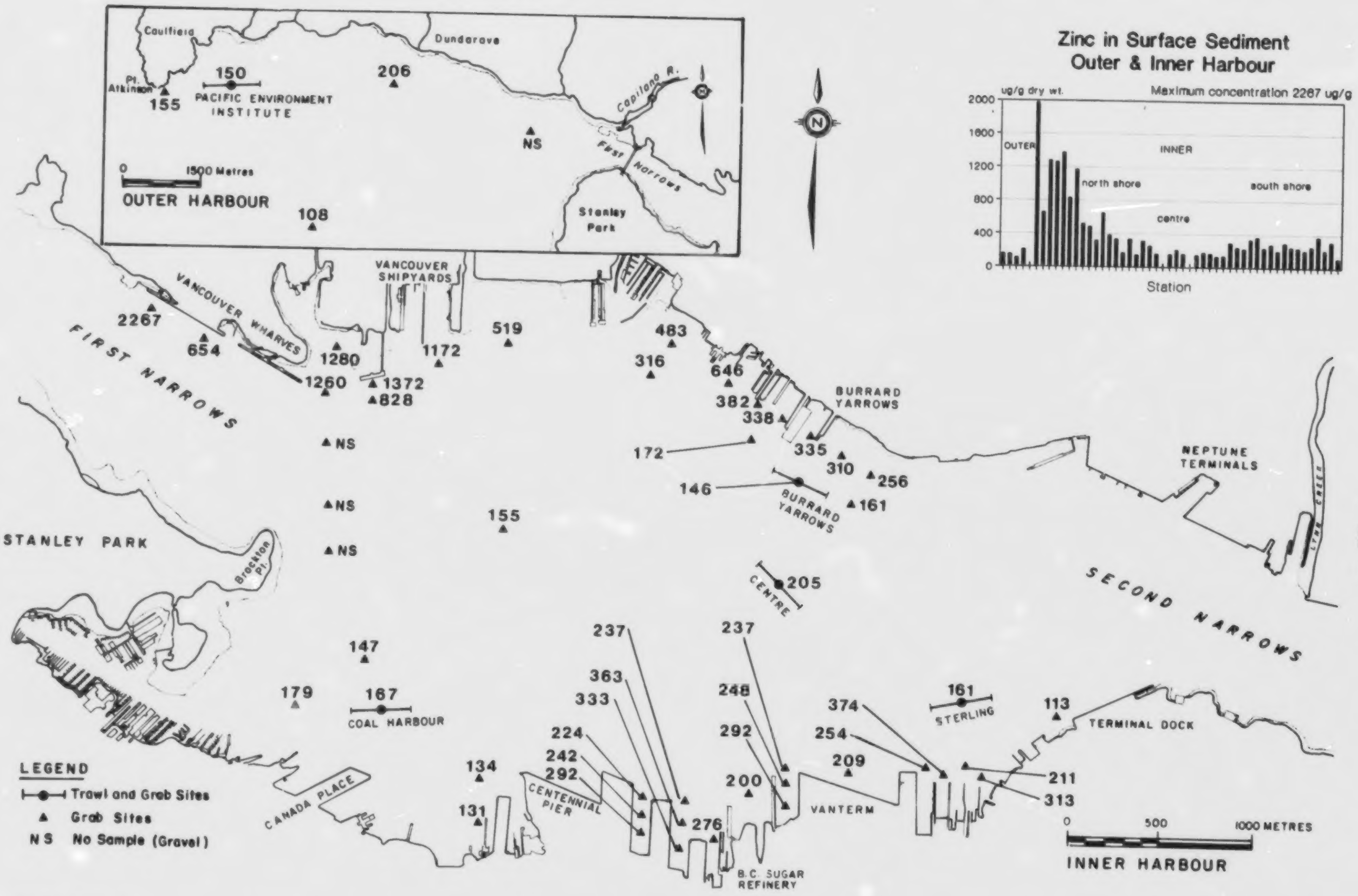
Zinc in Surface Sediment
Outer & Inner Harbour
ug/g dry wt.
Maximum concentration 2267 ug/g
2000
1600
1200
800
400
0
OUTER
INNER
north shore
centre
south shore
Station
Caulfield
Pt. Atkinson
155
150
PACIFIC ENVIRONMENT INSTITUTE
206
Dundarave
Capilano R.
First Narrows
Stanley Park
NS
108
0
1500 Metres
OUTER HARBOUR
N
VANCOUVER SHIPYARDS
VANCOUVER WHARVES
FIRST NARROWS
2267
654
1280
1260
1372
828
1172
519
483
316
646
382
338
BURRARD YARROWS
172
335
310
256
146
BURRARD YARROWS
161
NEPTUNE TERMINALS
LYNN CREEK
NS
NS
NS
155
STANLEY PARK
Brockton Pt.
205
CENTRE
SECOND NARROWS
147
179
167
COAL HARBOUR
134
131
CANADA PLACE
CENTENNIAL PIER
237
363
333
224
242
292
276
B.C. SUGAR REFINERY
237
248
292
200
VANTERM
374
254
209
161
STERLING
211
313
113
TERMINAL DOCK
0
500
1000 METRES
INNER HARBOUR
LEGEND
Trawl and Grab Sites
▲ Grab Sites
NS No Sample (Gravel)

FIGURE 9a Mean Surface Sediment Zinc Concentrations in µg/g Dry Weight (1985-86) Outer and Inner Harbour

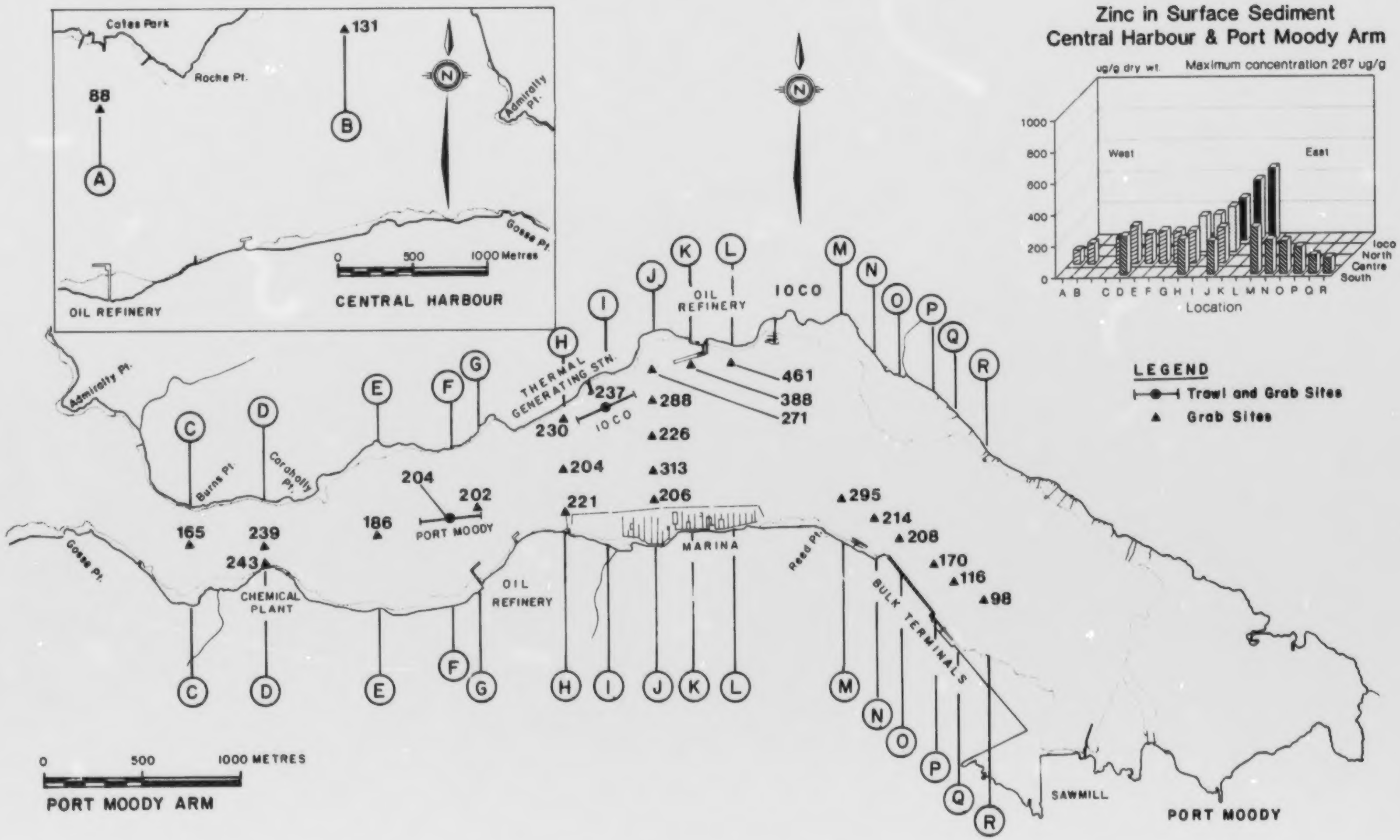
Zinc in Surface Sediment
Central Harbour & Port Moody Arm
ug/g dry wt.
Maximum concentration 267 ug/g
1000
800
600
400
200
0
West
East
A B C D E F G H I J K L M N O P Q R
Location
Ioco
North
Centre
South
LEGEND
Trawl and Grab Sites
Grab Sites
Cates Park
Roche Pt.
Admiralty Pt.
Gosse Pt.
OIL REFINERY
88
131
A
B
0
500
1000 Metres
CENTRAL HARBOUR
N
Burns Pt.
Caraholly Pt.
THERMAL GENERATING STN.
OIL REFINERY
IOCO
CHEMICAL PLANT
MARINA
Reed Pt.
BULK TERMINALS
SAWMILL
PORT MOODY
165
239
243
186
204
202
230
237
204
221
288
226
313
206
461
388
271
295
214
208
170
116
98
C
D
E
F
G
H
I
J
K
L
M
N
O
P
Q
R
0
500
1000 METRES
PORT MOODY ARM

FIGURE 9b Mean Surface Sediment Zinc Concentrations in µg/g Dry Weight (1985-86)- Central Harbour and Port Moody Arm.

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APPENDIX I

VANCOUVER HARBOUR SAMPLING STATION COORDINATES AND DEPTHS

APPENDIX I VANCOUVER HARBOUR SAMPLING STATION COORDINATES AND DEPTHS

AREA	STATION	SURVEY	LATITUDE	LONGITUDE	DEPTH (m)
OUTER HARBOUR					
	SB	May 85	49°18.23′N	123°13.78′W	55
	ATK	Sep 86	49°19.67′N	123°15.80′W	60
	PEI (Trawl)	May 85	49°19.80′N	123°13.73′W	59
		Oct 85	49°19.75′N	123°13.95′W	68
		Jan 86	49°19.55′N	123°13.92′W	67
		May 86	49°19.77′N	123°13.90′W	60
		Sep 86	49°19.80′N	123°13.94′W	58
	DD	Oct 85	49°19.70′N	123°11.65′W	25
INNER HARBOUR					
North Shore	1	Jun 86	49°18.72′N	123°07.45′W	13
	2	Jun 86	49°18.65′N	123°07.27′W	12
	3A	Sep 86	49°18.73′N	123°06.62′W	12
	3B	Sep 86	49°18.48′N	123°06.67′W	14
	4A	Nov 85	49°18.50′N	123°06.48′W	20
	4B	Sep 86	49°18.40′N	123°06.50′W	21
	5	Nov 85	49°18.58′N	123°06.21′W	24
	6	Nov 85	49°18.62′N	123°05.90′W	27
	7A	Nov 85	49°18.63′N	123°05.15′W	20
	7B	Nov 85	49°18.53′N	123°05.25′W	27
	8	Nov 85	49°18.52′N	123°04.89′W	16
	9	Nov 85	49°18.45′N	123°04.76′W	20
	10A	Nov 85	48°18.39′N	123°04.70′W	22
	10B	Nov 85	49°18.35′N	123°04.50′W	28
	11A	Nov 85	49°18.35′N	123°04.53′W	20
	11B (Trawl)	May 85	49°18.12′N	123°04.45′W	21
		Oct 85	49°18.10′N	123°04.40′W	23
		Jan 86	49°18.27′N	123°04.88′W	26
		May 86	49°18.30′N	123°04.88′W	28
		Sep 86	49°18.37′N	123°04.87′W	24
	12	Nov 85	49°18.27′N	123°04.39′W	24
	13A	Nov 85	49°18.23′N	123°04.27′W	24
	13B	Nov 85	49°18.26′N	123°04.18′W	26
Centre	14	Sep 86	49°18.10′N	123°05.83′W	25
	15 (Trawl)	Jan 86	49°18.01′N	123°05.07′W	43
		May 86	49°17.61′N	123°04.60′W	30
		Sep 86	49°17.95′N	123°05.00′W	18
	16 (Trawl)	May 85	49°17.60′N	123°03.87′W	21
		Oct 85	49°17.60′N	123°03.80′W	29
		May 86	49°17.60′N	123°03.87′W	20
		Sep 86	49°17.63′N	123°03.73′W	19

APPENDIX I VANCOUVER HARBOUR SAMPLING STATION COORDINATES AND DEPTHS (CONT'D)

AREA	STATION	SURVEY	LATITUDE	LONGITUDE	DEPTH (m)
South Shore	17	Sep 86	49°17.70'N	123°06.50'W	17
	18	Jan 86	49°17.41'N	123°06.65'W	14
	19 (Trawl)	May 85	49°17.47'N	123°06.15'W	18
		Oct 85	49°17.29'N	123°06.17'W	18
		Jan 86	49°17.47'N	123°06.30'W	18
		May 86	49°17.47'N	123°06.15'W	20
		Sep 86	49°17.48'N	123°06.28'W	19
	20A	Jun 86	49°17.22'N	123°05.99'W	14
	20B	Jun 86	49°17.35'N	123°05.99'W	18
	21A	Jun 86	49°17.16'N	123°05.77'W	14
	21B	Jun 86	49°17.23'N	123°05.77'W	20
	21C	Jun 86	49°17.30'N	123°05.77'W	28
	22A	Jun 86	49°17.15'N	123°05.08'W	13
	22B	Jun 86	49°17.20'N	123°05.08'W	18
	22C	Jun 86	49°17.28'N	123°05.08'W	28
	23	Jun 86	49°17.20'N	123°04.94'W	19
	24	Jun 86	49°17.32'N	123°04.78'W	22
	25A	Jun 86	49°17.28'N	123°04.54'W	32
	25B	Jun 86	49°17.33'N	123°04.54'W	29
	25C	Jun 86	49°17.38'N	123°04.54'W	26
	26	Jun 86	49°17.37'N	123°04.33'W	26
	27	Jun 86	49°17.41'N	123°03.99'W	14
	28	Jun 86	49°17.36'N	123°03.84'W	17
	29	Jun 86	49°17.41'N	123°03.81'W	21
	30	Jun 86	49°17.37'N	123°03.73'W	13
	31	Jun 86	49°17.60'N	123°03.40'W	29
CENTRAL HARBOUR					
	CP	May 85	49°17.95'N	122°57.78'W	28
	BR	May 85	49°18.20'N	122°56.36'W	32
EASTERN HARBOUR					
Port Moody Arm	32	May 85	49°17.49'N	122°55.00'W	20
	33A	May 85	49°17.47'N	122°54.66'W	22
	33B	May 85	49°17.49'N	122°54.70'W	32
	34	May 85	49°17.49'N	122°54.25'W	17
	35 (Trawl)	May 85	49°17.61'N	122°53.83'W	17
		Oct 85	49°17.62'N	122°53.78'W	15
		Jan 86	49°17.61'N	122°53.81'W	18
		May 86	49°17.64'N	122°53.80'W	18
		Sep 86	49°17.61'N	122°53.85'W	16
	36	Nov 85	49°17.70'N	122°53.70'W	17
	37A	Nov 85	49°17.83'N	122°53.40'W	15
	37B	Nov 85	49°17.70'N	122°53.43'W	15
	37C	Nov 85	49°17.56'N	122°53.42'W	15

APPENDIX I VANCOUVER HARBOUR SAMPLING STATION COORDINATES AND DEPTHS (CONCLUDED)

AREA	STATION	SURVEY	LATITUDE	LONGITUDE	DEPTH (m)
	38	Jan 86	49°17.95′N	122°53.10′W	12
		May 86	49°17.95′N	122°53.15′W	14
		Sep 86	49°17.91′N	122°53.10′W	15
	39A	Nov 85	49°18.00′N	122°53.02′W	10
	39B	May 85	49°17.90′N	122°53.02′W	12
	39C	Nov 85	49°17.80′N	122°53.02′W	12
	39D	Nov 85	49°17.70′N	122°53.02′W	13
	39E	Nov 85	49°17.60′N	122°53.02′W	13
	40	Nov 85	49°17.95′N	122°52.90′W	12
	41	Nov 85	49°17.95′N	122°52.70′W	8
	42	May 85	49°17.61′N	122°52.23′W	13
	43	May 85	49°17.56′N	122°52.11′W	13
	44	May 85	49°17.50′N	122°51.98′W	14
	45	May 85	49°17.45′N	122°51.85′W	14
	46	May 85	49°17.39′N	122°51.73′W	14
	47	May 85	49°17.35′N	122°51.60′W	11

Note: (Trawl) denotes sediment sampling stations corresponding to otter trawl sampling sites (biota sampling)

APPENDIX II

SEDIMENT TRACE METAL CONCENTRATIONS IN STANDARD REFERENCE MATERIALS (BCSS-1 AND MESS-1) AND PERCENT RECOVERY BY EP LABORATORY

A. MAY 1985
B. OCTOBER 1985
C. NOVEMBER 1985
D. JANUARY 1986
E. MAY 1986
F. JUNE 1986
G. SEPTEMBER 1986

APPENDIX IIA SEDIMENT TRACE METAL CONCENTRATIONS IN STANDARD REFERENCE MATERIALS (BCSS-1 AND MESS-1) AND PERCENT RECOVERY BY EP LABORATORY - MAY 1985

	CONCENTRATION (µg/g dry weight)													
	Al	As*	Ba	Cd*	Cr*	Cu*	Fe	Hg*	Mg	Mn*	Mo	Ni*	Pb*	Zn
BCSS-1 (CERTIFIED(*) AND NONCERTIFIED VALUES)														
MEAN	62600	11.1	330	0.25	123	18.5	32900	0.129	14700	229	1.5	55.3	22.7	119
± 95% C.L.	2200	1.4	0	0.4	14	2.7	1000	0.012	1600	15	0	3.6	3.4	12
LABORATORY RESULTS														
	22400	<8	53.6	<0.3	52.9	15.1	30700	0.163	10700	190	<0.8	45	12	103
	23100	<8	50.0	<0.3	54.3	15.0	31500	-	10900	198	<0.8	45	12	106
	23100	<8	56.3	<0.3	54.6	15.2	31400	-	10900	195	<0.8	46	11	106
MEAN(3)	22867	-	53.3	-	53.9	15.1	31200	-	10833	194	-	45	12	105
% RECOVERY	37	-	16	-	44	82	95	126	74	85	-	81	53	88
MESS-1 (CERTIFIED(*) AND NONCERTIFIED VALUES)														
MEAN	58000	10.6	270	0.59	71	25.1	30500	0.171	8680	513	2.2	29.5	34.0	191
± 95% C.L.	2000	1.2	0	0.10	11	3.8	1500	0.014	542	25	0	2.7	6.1	17
LABORATORY RESULTS														
	19200	<8	45.5	0.4	33.2	23.2	29300	0.190	6380	357	<0.8	22	24	194
	18500	<8	47.0	<0.3	31.3	22.3	28200	0.194	6140	339	<0.8	21	26	177
	18200	<8	44.7	<0.3	30.9	23.6	27100	-	6050	328	<0.8	21	24	172
	18200	<8	46.7	<0.3	30.4	22.6	27300	-	6090	326	<0.8	23	24	177
MEAN(4)	18525	<8	46.0	-	31.5	22.9	27975	0.192	6165	338	<0.8	22	25	180
% RECOVERY	32	-	17	-	44	91	92	112	71	66	-	75	74	94

APPENDIX IIB SEDIMENT TRACE METAL CONCENTRATIONS IN STANDARD REFERENCE MATERIALS (BCSS-1 AND MESS-1) AND PERCENT RECOVERY BY EP LABORATORY - OCTOBER 1985

	CONCENTRATION (μg/g dry weight)													
	Al	As*	Ba	Cd*	Cr*	Cu*	Fe	Hg*	Mg	Mn*	Mo	Ni*	Pb*	Zn
BCSS-1 (CERTIFIED(*) AND NONCERTIFIED VALUES)														
MEAN	62600	11.1	330	0.25	123	18.5	32900	0.129	14700	229	1.5	55.3	22.7	119
± 95% C.L.	2200	1.4	0	0.4	14	2.7	1000	0.012	1600	15	0	3.6	3.4	12
LABORATORY RESULTS														
	20300	<8	49.3	<0.30	53.2	18.3	28800	0.170	12700	225	<0.8	49	19	113
	20300	<8	45.6	<0.30	53.1	17.2	28500	0.160	12300	220	<0.8	50	15	113
	19600	<8	45.3	<0.30	52.4	16.8	28100	0.163	11900	216	<0.8	48	17	109
	18700	<8	39.1	<0.30	51.1	16.1	27700	0.156	11600	213	<0.8	47	12	107
	20100	<8	49.8	<0.30	52.4	18.2	28000	0.163	12200	219	<0.8	48	16	108
MEAN(3)	19800	<8	45.8	0.30	52.4	17.3	28220	0.162	12140	219	<0.8	48	16	110
% RECOVERY	32	-	14	-	43	94	86	126	83	96	-	87	70	92
MESS-1 (CERTIFIED(*) AND NONCERTIFIED VALUES)														
MEAN	58000	10.6	270	0.59	71	25.1	30500	0.171	8680	513	2.2	29.5	34.0	191
± 95% C.L.	2000	1.2	0	0.1	11	3.8	1500	0.014	542	25	0	2.7	6.1	17
LABORATORY RESULTS														
	17000	<8	46.8	0.63	31.4	25.3	25000	0.202	6960	373	<0.8	22	29	183
	16400	<8	42.2	0.63	30.4	24.8	24500	0.209	6670	367	<0.8	21	24	175
	16300	<8	41.6	<0.63	30.9	25.2	24600	0.217	6600	364	<0.8	22	24	179
	16400	<8	46.7	<0.60	30.9	24.3	24700	0.217	6740	367	<0.8	22	24	180
	17300	<8	44.7	<0.63	31.9	28.0	25300	0.206	7040	376	<0.8	22	28	193
MEAN(4)	16680		44.4	<0.62	31.1	25.5	24820	0.210	6802	369	-	22	26	182
% RECOVERY	29	-	16	105	44	102	81	123	78	72	-	75	76	95

APPENDIX IIC SEDIMENT TRACE METAL CONCENTRATIONS IN STANDARD REFERENCE MATERIALS (BCSS-1 AND MESS-1) AND PERCENT RECOVERY BY EP LABORATORY - NOVEMBER 1985

	CONCENTRATION (µg/g dry weight)												
	Al	As*	Ba	Cd*	Cr*	Cu*	Fe	Mg	Mn*	Mo	Ni*	Pb*	Zn
BCSS-1 (CERTIFIED(*) AND NONCERTIFIED VALUES)													
MEAN	62600	11.1	330	0.25	123	18.5	32900	14700	229	1.5	55.3	22.7	119
± 95% C.L.	2200	1.4	0	0.4	14	2.7	1000	1600	15	0	3.6	3.4	12
LABORATORY RESULTS													
	20200	<8	45.6	0.5	48.8	17	30300	11800	220	5.8	41	28	103
	19800	<8	50.5	0.3	57.9	19	29700	11800	242	<0.8	49	29	121
	19900	<8	54.2	0.4	59.6	19	29000	11600	242	<0.8	48	28	120
	20700	<8	63.1	0.4	61.6	19	29400	11700	246	<0.8	49	23	123
	20700	<8	49.8	0.5	48.1	16	29200	11600	216	8.6	43	31	98
MEAN(3)	20260	-	52.6	0.4	55.2	18	29520	11700	233	-	46	28	113
% RECOVERY	32	-	16	160	45	97	90	80	102	-	83	123	95
MESS-1 (CERTIFIED(*) AND NONCERTIFIED VALUES)													
MEAN	58000	10.6	270	0.59	71	25.1	30500	8680	513	2.2	29.5	34	191
± 95% C.L.	2000	1.2	0	0.1	11	3.8	1500	542	25	0	2.7	6	17
LABORATORY RESULTS													
	16900	<8	52.2	0.5	32.0	27	25300	6700	402	<0.8	23	39	190
	16500	<8	47.5	0.5	34.0	27	25000	6590	404	<0.8	20	46	196
	17100	<8	49.8	0.5	32.7	28	25600	6790	399	<0.8	21	41	183
	16600	<8	47.9	0.7	34.4	31	25100	6600	410	<0.8	22	35	197
	18100	<8	52.5	0.7	33.0	29	26300	6810	407	<0.8	22	41	189
MEAN(4)	17040	-	50.0	0.6	33.2	28	25460	6698	404	-	22	40	191
% RECOVERY	29	-	19	102	47	112	83	77	79	-	75	118	100

APPENDIX IID SEDIMENT TRACE METAL CONCENTRATIONS IN STANDARD REFERENCE MATERIALS (BCSS-1 AND MESS-1) AND PERCENT RECOVERY BY EP LABORATORY - JANUARY 1986

	CONCENTRATION (µg/g dry weight)												
	Al	As*	Ba	Cd*	Cr*	Cu*	Fe	Mg	Mn*	Mo	Ni*	Pb*	Zn
BCSS-1 (CERTIFIED(*) AND NONCERTIFIED VALUES)													
MEAN	62600	11.1	330	0.25	123	18.5	32900	14700	229	1.5	55.3	22.7	119
± 95% C.L.	2200	1.4	0	0.4	14	2.7	1000	1600	15	0	3.6	3.4	12
LABORATORY RESULTS													
	20200	<8	45.6	0.5	48.8	17	30300	11800	220	5.8	41	28	103
	19800	<8	50.5	0.3	57.9	19	29700	11800	242	<0.8	49	29	121
	19900	<8	54.2	0.4	59.6	19	29000	11600	242	<0.8	48	28	120
	20700	<8	63.1	0.4	61.6	19	29400	11700	246	<0.8	49	23	123
	20700	<8	49.8	0.5	48.1	16	29200	11600	216	8.6	43	31	98
MEAN(3)	20260	-	52.6	0.4	55.2	18	29520	11700	233	-	46	28	113
% RECOVERY	32	-	16	160	45	97	90	80	102	-	83	123	95
MESS-1 (CERTIFIED(*) AND NONCERTIFIED VALUES)													
MEAN	58000	10.6	270	0.59	71	25.1	30500	8680	513	2.2	29.5	34	191
± 95% C.L.	2000	1.2	0	0.1	11	3.8	1500	542	25	0	2.7	6	17
LABORATORY RESULTS													
	16900	<8	52.2	0.5	32.0	27	25300	6700	402	<0.8	23	39	190
	16500	<8	47.5	0.5	34.0	27	25000	6590	404	<0.8	20	46	196
	17100	<8	49.8	0.5	32.7	28	25600	6790	399	<0.8	21	41	183
	16600	<8	47.9	0.7	34.4	31	25100	6600	410	<0.8	22	35	197
	18100	<8	52.5	0.7	33.0	29	26300	6810	407	<0.8	22	41	189
MEAN(4)	17040	-	50.0	0.6	33.2	28	25460	6698	404	-	22	40	191
% RECOVERY	29	-	19	102	47	112	83	77	79	-	75	118	100

APPENDIX III SEDIMENT TRACE METAL CONCENTRATIONS IN STANDARD REFERENCE MATERIALS
(BCSS-1 AND MESS-1) AND PERCENT RECOVERY BY EP LABORATORY - MAY 1986

	CONCENTRATION (µg/g dry weight)																	
	Al	As*	Ba	Cd*	Co*	Cr*	Cu*	Fe	Hg*	Mg	Mn*	Mo	Ni*	Pb*	Sn	Sr	V*	Zn*
BCSS-1 (CERTIFIED(*) AND NONCERTIFIED VALUES)																		
MEAN	62600	11.1	330	0.25	11.4	123	18.5	32900	0.129	14700	229	1.5	55.3	22.7	3	96	93.4	119
± 95% C.L.	2200	1.4	0	0.4	2.1	14	2.7	1000	0.012	1600	15	0	3.6	3.4	0	0	4.9	12
LABORATORY RESULTS																		
	22200	<8	60.9	0.36	11.4	64.3	18.0	34200	0.159	12900	250	<0.8	56	25	7	41.0	59.2	126
	20100	9	54.3	0.31	11.8	59.9	17.0	32300	0.140	12000	237	<0.8	52	26	3	38.0	55.9	119
	20100	<8	59.1	0.43	10.9	59.8	17.0	32100	0.173	11900	234	<0.8	52	25	5	37.6	55.0	123
	20800	17	51.8	0.36	14.7	61.8	17.7	32400	0.154	11900	237	<0.8	54	28	3	37.8	56.4	121
	19700	9	52.2	0.36	11.9	58.7	16.3	31500	0.163	11600	230	<0.8	51	25	4	37.1	54.1	117
MEAN(3)	20580	-	55.7	0.36	12.1	60.9	17.2	32500	0.158	12060	238	-	53	26	4	38	56	121
% RECOVERY	33	-	17	144	106	50	93	99	122	82	104	-	96	115	133	40	60	102
MESS-1 (CERTIFIED(*) AND NONCERTIFIED VALUES)																		
MEAN	58000	10.6	270	0.59	10.8	71	25.1	30500	0.171	8680	513	2.2	29.5	34	6	89	72.4	191
± 95% C.L.	2000	1.2	0	0.1	1.9	11	3.8	1500	0.014	542	25	0	2.7	6.1	0	0	5.3	17
LABORATORY RESULTS																		
	18600	14	56.9	0.62	16.3	38.7	26.5	30500	0.207	7120	432	<0.8	26	41	7	35.1	49.3	190
	17600	25	53.1	0.54	12.7	36.9	25.5	29400	0.188	6860	418	<0.8	26	40	<2	33.6	46.8	196
	17600	17	51.9	0.63	11.8	37.1	25.3	29800	0.204	6920	418	<0.8	25	37	<2	33.7	46.7	183
	17500	24	53.3	0.67	15.6	37.9	24.2	29500	0.284	6750	420	<0.8	25	42	<2	33.1	47.4	197
	16800	20	45.2	0.55	13.2	36.3	24.7	29600	0.206	6710	412	<0.8	26	36	<2	32.3	45.7	189
MEAN(4)	17620	20	52.1	0.60	13.9	37.4	25.2	29760	0.218	6872	420	-	26	39	-	33.6	47.2	191
% RECOVERY	30	189	19	102	129	53	100	98	127	79	82	-	88	115	-	38	65	107

APPENDIX IIF SEDIMENT TRACE METAL CONCENTRATIONS IN STANDARD REFERENCE MATERIALS (BCSS-1 AND MESS-1) AND PERCENT RECOVERY BY EP LABORATORY - JUNE 1986

	CONCENTRATION (µg/g dry weight)																	
	Al	As*	Ba	Cd*	Co*	Cr*	Cu*	Fe	Hg*	Mg	Mn*	Mo	Ni*	Pb*	Sn	Sr	V*	Zn*
BCSS-1 (CERTIFIED(*) AND NONCERTIFIED VALUES)																		
MEAN	62600	11.1	330	0.25	11.4	123	18.5	32900	0.129	14700	229	1.5	55.3	22.7	3	96	93.4	119
± 95% C.L.	2200	1.4	0	0.4	2.1	14	2.7	1000	0.012	1600	15	0	3.6	3.4	0	0	4.9	12
LABORATORY RESULTS																		
	16800	8	45.8	0.54	13.3	32.5	26.5	26400	0.170	6800	371	<0.8	20	36	<2	31.4	42.4	182
	17900	15	51.8	0.52	8.7	33.6	24.2	26100	0.187	6730	374	<0.8	19	35	<2	31.6	43.7	169
	18800	20	53.4	0.64	6.9	34.9	25.4	27600	0.180	7150	395	<0.8	20	34	<2	33.4	45.0	189
	18800	<8	58.5	0.89	12.3	34.5	24.8	27000	0.227	7000	390	<0.8	22	34	3	33.0	44.7	179
	19400	14	55.5	0.65	7.6	34.9	26.2	27200	0.222	7080	392	<0.8	19	31	<2	32.8	46.2	182
MEAN(3)	18340	-	53.0	0.65	9.8	34.1	25.4	26860	0.197	6952	384	-	20	34	-	32.4	44.4	180
% RECOVERY	29	-	16	260	86	28	137	82	153	47	168	-	36	150	<73	34	48	151
MESS-1 (CERTIFIED(*) AND NONCERTIFIED VALUES)																		
MEAN	58000	10.6	270	0.6	10.8	71	25.1	30500	0.171	8680	513	2.2	29.5	34	6	89	72.4	191
± 95% C.L.	2000	1.2	0	0.1	1.9	11	3.8	1500	0.014	542	25	0	2.7	6	0	0	5.3	17
LABORATORY RESULTS																		
	22100	17	55.2	0.34	10.1	58.0	17.6	29700	0.144	12100	215	<0.8	46	25	2	36.2	53.8	108
	21700	20	57.6	0.31	9.2	57.0	17.1	29500	0.115	11900	213	<0.8	46	22	<2	36.1	54.3	105
	22600	22	60.9	0.32	12.4	59.1	16.8	29800	0.123	12100	216	<0.8	45	26	<2	36.8	55.7	108
	23100	21	62.7	0.31	10.8	60.2	17.1	30600	0.150	12400	220	<0.8	46	27	7	37.0	57.1	107
	22600	22	57.0	0.37	6.6	60.1	17.1	31200	0.112	12600	226	<0.8	47	23	11	37.8	56.4	113
MEAN(4)	22420	20	58.7	0.33	9.8	58.9	17.1	30160	0.129	12200	218	-	46	25	-	36.8	55.5	108
% RECOVERY	39	189	22	55	91	83	68	99	75	141	42	-	156	74	-	41	77	57

APPENDIX IIG SEDIMENT TRACE METAL CONCENTRATIONS IN STANDARD REFERENCE MATERIALS
(BCSS-1 AND MESS-1) AND PERCENT RECOVERY BY EP LABORATORY - SEPTEMBER 1986

	CONCENTRATION (µg/g dry weight)																	
	Al	As*	Ba	Cd*	Co*	Cr*	Cu*	Fe	Hg*	Mg	Mn*	Mo	Ni*	Pb*	Sn	Sr	V*	Zn*
BCSS-1 (CERTIFIED(*) AND NONCERTIFIED VALUES)																		
MEAN	62600	11.1	330	0.25	11.4	123	18.5	32900	0.129	14700	229	1.5	55.3	22.7	3	96	93.4	119
± 95% C.L.	2200	1.4	0	0.04	2.1	14	2.7	1000	0.012	1600	15	0	3.6	3.4	0	0	4.9	12
LABORATORY RESULTS																		
	23600	<8	62.2	0.70	11.4	59.9	18.3	30200	0.085	12700	223	<0.8	51	34	5	37.9	59.0	119
	22700	9	56.4	0.23	10.3	58.1	17.3	29400	0.104	12200	218	<0.8	48	32	3	36.6	56.4	114
	23000	<8	60.5	0.25	9.7	58.3	17.4	29400	0.109	12200	217	<0.8	49	32	2	36.9	57.0	113
	23000	<8	55.9	0.70	11.0	57.8	17.3	29300	0.112	12300	217	<0.8	49	32	<2	36.9	56.6	112
	23600	<8	58.2	0.60	12.2	58.8	17.4	29600	0.115	12500	219	<0.8	50	36	6	37.4	57.9	114
MEAN(3)	23180	-	58.6	0.50	10.9	58.6	17.5	29580	0.105	12380	219	-	49	33	-	37.1	57.4	114
% RECOVERY	37	-	18	200	96	48	95	90	81	84	96	-	89	145	-	39	61	96
MESS-1 (CERTIFIED(*) AND NONCERTIFIED VALUES)																		
MEAN	58000	10.6	270	0.59	10.8	71	25.1	30500	0.171	8680	513	2.2	29.5	34	6	89	72.4	191
± 95% C.L.	2000	1.2	0	0.1	1.9	11	3.8	1500	0.014	542	25	0	2.7	6.1	0	0	5.3	17
LABORATORY RESULTS																		
	19700	<8	56.0	0.80	11.8	34.9	26.0	26600	0.132	6930	395	<0.8	22	42	5	33.4	48.2	185
	19100	<8	52.4	0.60	12.0	34.3	26.3	26400	0.173	6900	388	<0.8	22	42	3	33.1	46.8	188
	19200	<8	52.0	0.57	13.5	35.0	25.3	26800	0.172	6920	394	<0.8	24	43	<2	33.3	47.7	189
	19300	<8	55.3	0.70	14.3	34.4	25.5	26500	0.167	7020	386	<0.8	24	44	3	33.3	46.8	192
	19600	<8	51.7	0.56	13.3	35.3	25.0	26900	0.184	7120	390	<0.8	23	44	2	33.8	47.6	189
MEAN(4)	19380	<8	53.5	0.65	13.0	34.8	25.6	26640	0.166	6978	391	-	23	43	-	33.4	47.4	189
% RECOVERY	33	-	20	108	130	49	102	87	97	80	76	-	78	126	-	38	65	99

APPENDIX III

RAW DATA OF SEDIMENT TRACE METAL CONCENTRATIONS

A. MAY 1985
B. OCTOBER 1985
C. NOVEMBER 1985
D. JANUARY 1986
E. MAY 1986
F. JUNE 1986
G. SEPTEMBER 1986

APPENDIX IIIA RAW DATA OF SEDIMENT TRACE METAL CONCENTRATIONS - MAY 1985

STATION	CONCENTRATION (µg/g dry weight)													
	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
SB	24600	<8	75.8	<0.3	50.9	64.6	38600	0.123	12700	448	<0.8	39	15	106
	23900	<8	71.9	<0.3	50.3	65.2	38400	0.149	12500	463	<0.8	39	20	112
	24300	<8	76.0	<0.3	49.9	65.5	38500	0.147	12400	458	<0.8	38	17	105
PEI	27600	<8	82.1	<0.3	50.9	219.0	40600	0.267	12800	436	<0.8	38	42	144
	27500	<8	81.3	<0.3	52.0	208.0	40800	0.213	12700	452	<0.8	39	40	145
	27500	<8	83.4	<0.3	52.2	212.0	41700	0.241	12800	463	<0.8	38	38	142
11B	13600	<8	40.2	<0.3	29.1	131.0	33300	0.114	4750	273	<0.8	13	25	107
	12100	<8	25.1	<0.3	20.6	127.0	26700	0.069	3880	233	<0.8	8	18	91
	11500	<8	28.2	<0.3	26.3	135.0	35300	0.092	3800	249	<0.8	7	18	82
16	23400	<8	73.9	<0.3	39.0	348.0	33400	0.423	9400	355	<0.8	27	68	184
	22400	<8	70.1	0.4	36.7	297.0	32000	0.508	8770	338	<0.8	25	63	194
	22000	<8	71.4	<0.3	35.6	303.0	31400	0.337	8490	329	<0.8	25	60	171
19	22700	<8	70.9	<0.3	33.9	244.0	31900	0.300	8490	338	<0.8	22	60	141
	22500	<8	71.6	<0.3	35.1	273.0	32500	0.261	8300	336	<0.8	22	59	157
	23400	<8	74.1	<0.3	36.4	249.0	34000	0.289	8420	351	<0.8	26	60	162
CP	12800	<8	34.1	<0.3	24.3	62.5	29700	0.119	4110	252	<0.8	7	16	80
	12500	<8	32.3	<0.3	40.2	73.1	52400	0.106	4160	306	<0.8	8	24	113
	12300	<8	31.0	<0.3	21.1	55.9	27100	0.091	3800	246	<0.8	7	18	70
BR	21000	<8	60.4	0.5	30.2	154.0	28200	0.289	7700	312	<0.8	18	48	135
	20500	<8	60.8	0.3	30.6	154.0	28600	0.271	7660	316	<0.8	19	50	135
	20400	<8	57.9	0.6	29.0	149.0	27600	0.251	7180	303	<0.8	17	45	124

APPENDIX IIIA RAW DATA OF SEDIMENT TRACE METAL CONCENTRATIONS - MAY 1985 (Conclusion)

STATION	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
	CONCENTRATION (µg/g dry weight)													
32	27500	<8	81.9	0.4	49.7	193.0	37500	0.402	10600	382	<0.8	26	76	171
	25000	<8	80.0	0.4	43.0	179.0	32500	0.403	9350	336	<0.8	23	69	151
	27300	<8	80.7	<0.3	50.5	198.0	38100	0.455	10800	386	<0.8	27	79	174
33A	27200	<8	87.4	<0.3	49.1	234.0	59200	0.302	10200	356	<0.8	22	98	243
33B	25600	<8	88.6	0.4	47.4	200.0	46500	0.323	9440	346	<0.8	23	80	211
	25200	<8	88.1	0.4	46.5	200.0	47700	0.286	9380	338	<0.8	24	81	220
	25200	<8	89.7	0.6	49.2	241.0	55500	0.193	9920	349	<0.8	24	92	285
34	28000	<8	82.9	0.6	60.0	183.0	39500	0.378	11100	374	<0.8	27	91	188
	28600	<8	84.4	0.3	59.4	178.0	38900	0.407	11100	377	<0.8	28	88	184
	27900	<8	80.9	0.4	58.3	180.0	39000	0.459	11100	371	<0.8	27	90	186
35	27700	<8	78.6	0.5	64.9	163.0	37600	0.381	10500	354	<0.8	27	94	187
	29500	<8	86.2	0.7	66.6	171.0	39700	0.458	10900	369	<0.8	28	98	198
	29300	<8	82.7	0.6	66.4	168.0	39000	0.471	11300	365	<0.8	28	96	197
42	27600	<8	74.5	3.1	63.9	98.4	36300	0.291	9450	336	<0.8	28	76	295
43	25500	<8	63.3	2.0	54.1	78.3	33500	0.239	9420	323	<0.8	26	54	214
44	29000	<8	74.2	2.4	60.4	88.4	36500	0.279	10300	346	<0.8	27	57	208
45	27300	<8	67.4	1.8	55.5	79.0	35500	0.230	10400	341	<0.8	26	48	170
46	28800	<8	74.3	1.6	49.2	57.0	35600	0.155	11100	371	<0.8	29	24	116
47	30400	<8	78.9	1.5	45.0	48.4	35300	0.127	11700	379	<0.8	29	12	98

APPENDIX IIIB RAW DATA OF SEDIMENT TRACE METAL CONCENTRATIONS - OCTOBER 1985

STATION	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
	CONCENTRATION (µg/g dry weight)													
PEI	27500	<8	87.2	0.28	55.2	206	39400	0.261	15500	507	<0.8	44	47	152
	25300	<8	78.7	0.28	53.2	187	37500	0.290	14800	490	<0.8	43	41	145
	24100	<8	75.0	0.30	52.2	197	36900	0.308	14200	471	<0.8	42	42	143
DD	23900	<8	76.0	0.88	49.9	449	36800	0.308	12900	445	<0.8	42	76	209
	19800	<8	60.4	0.72	50.2	501	42800	0.249	9780	392	<0.8	29	61	195
	17500	<8	54.0	0.83	51.0	561	43600	0.210	8550	364	<0.8	33	64	214
11B	14600	<8	51.1	0.62	47.3	207	52200	0.114	6420	353	<0.8	14	49	151
	13500	<8	52.4	0.59	31.0	190	33500	0.097	5990	307	<0.8	12	35	146
	13200	<8	42.5	0.57	42.4	177	48800	0.124	5730	339	<0.8	15	37	125
16	17800	<8	58.3	0.74	31.5	280	26400	0.321	8270	331	<0.8	21	54	153
	19000	<8	63.6	0.78	33.0	284	26300	0.487	8450	335	<0.8	22	61	168
	19600	<8	0.54	0.54	31.7	260	26000	0.206	8720	339	<0.8	22	63	130
19	21700	<8	75.0	0.56	35.1	331	27800	0.196	9630	361	<0.8	23	62	151
	18500	<8	63.5	0.63	33.3	281	27200	0.244	8200	334	<0.8	24	58	148
	18900	<8	68.9	0.59	34.2	289	27800	0.227	8690	342	<0.8	22	62	155
35	26000	<8	78.9	0.72	68.2	182	35400	0.518	12400	400	<0.8	29	106	203
	25000	<8	78.4	0.74	62.4	179	38200	0.468	11800	390	<0.8	27	100	200
	26100	<8	81.8	0.86	66.1	184	36800	0.492	12400	405	<0.8	28	101	203

APPENDIX IIIC RAW DATA OF SEDIMENT TRACE METAL CONCENTRATIONS - NOVEMBER 1985

	CONCENTRATION (µg/g dry weight)												
STATION	Al	As	Ba	Cd	Cr	Cu	Fe	Mg	Mn	Mo	Ni	Pb	Zn
4A	20100	<8	77.0	2.1	44.2	1700	35100	6600	263	23.8	39	186	1630
	22700	52	137.0	5.7	81.9	1830	32900	7990	464	<0.8	45	193	2220
	29000	<8	77.0	0.4	105.0	89	35600	11600	294	29.8	26	108	266
5	24600	<8	83.1	0.5	29.9	580	29700	9420	264	27.0	18	85	541
	25200	<8	71.1	0.4	32.6	361	30200	10200	220	14.6	13	82	455
	22400	23	130.0	3.7	51.8	685	28800	8400	348	13.6	27	112	2520
6	25200	<8	89.4	0.5	39.0	346	31900	10500	312	25.3	19	87	455
	25800	33	136.0	1.6	75.5	604	31500	11300	470	<0.8	28	122	711
	26600	<8	95.8	0.5	44.5	368	31800	11700	314	13.5	21	81	391
7A	24700	<8	94.0	0.6	57.0	305	30500	10400	395	10.6	23	102	489
	24200	<8	97.1	0.5	47.0	285	30100	9930	357	17.6	20	93	422
	23100	12	119.0	0.6	61.6	330	28900	9610	419	4.9	24	103	539
7B	23700	<8	97.6	0.4	53.1	288	30600	9810	367	7.9	23	77	357
	23600	<8	38.7	0.5	13.1	85	30900	9780	135	34.7	8	50	118
	23700	33	116.0	0.3	60.5	369	30400	9590	417	<0.8	26	89	472
8	20000	<8	106.0	0.4	37.1	237	27500	8080	311	23.3	17	87	652
	19900	9	112.0	0.5	40.0	240	27300	7760	285	4.6	14	81	640
	21700	9	111.0	0.4	42.6	249	28100	8400	306	9.1	20	96	647
9	22900	<8	109.0	0.5	39.0	234	28700	9150	313	20.0	18	87	389
	23300	<8	103.0	0.3	33.6	225	29500	9690	272	20.6	15	82	377
	22000	<8	95.9	0.6	39.9	220	29100	8790	298	23.3	15	84	380

APPENDIX IIIC RAW DATA OF SEDIMENT TRACE METAL CONCENTRATIONS - NOVEMBER 1985 (continued)

STATION	CONCENTRATION (µg/g dry weight) Al	As	Ba	Cd	Cr	Cu	Fe	Mg	Mn	Mo	Ni	Pb	Zn
10A	22000	<8	96.7	0.6	41.8	221	29700	8780	328	18.8	20	75	404
	22600	<8	78.2	0.5	34.3	169	30600	9080	275	25.3	15	62	231
	21900	32	110.0	0.9	65.9	308	29100	9240	442	<0.8	26	82	379
10B	23500	<8	86.9	0.4	50.3	236	29600	9630	346	3.8	20	66	270
	23100	<8	38.0	0.5	11.8	74	28700	9090	135	32.9	7	42	93.2
	23800	<8	53.1	0.5	26.4	128	30900	9740	230	25.8	13	49	153
11A	17900	22	94.0	0.5	41.0	175	26000	6960	309	8.7	14	64	387
	17200	<8	65.2	0.6	30.3	137	26000	6660	240	14.3	12	75	322
	18600	<8	89.8	0.6	26.7	132	25700	6970	255	21.1	13	72	296
12	20000	<8	82.9	0.4	42.7	118	38000	7990	297	19.1	13	63	256
	20100	17	91.8	0.8	56.9	186	33000	7830	360	4.2	17	108	402
	22800	<8	96.1	0.5	49.2	173	36700	9380	345	38.5	15	59	271
13A	17000	<8	56.2	0.5	56.8	117	53700	6520	297	14.5	10	50	220
	18800	<8	78.1	0.5	58.7	154	41900	7820	350	10.8	16	62	273
	16300	<8	79.2	0.7	108.0	157	56100	6390	507	<0.8	14	60	274
13B	18200	<8	59.9	0.5	40.9	127	33100	7050	291	9.9	11	42	165
	18500	<8	60.7	0.4	39.4	133	40600	7460	278	24.1	11	44	180
	14600	<8	50.8	0.3	36.9	85	32500	5290	259	15.4	8	32	137
36	26700	<8	89.3	0.4	66.6	189	38300	12300	437	<0.8	27	115	188
	26900	13	95.9	2.0	73.2	199	36900	12400	455	<0.8	29	120	211
	26800	<8	93.5	0.3	71.1	192	37300	11900	443	<0.8	27	125	207

APPENDIX IIIC RAW DATA OF SEDIMENT TRACE METAL CONCENTRATIONS - NOVEMBER 1985 (continued)

STATION	CONCENTRATION (µg/g dry weight) Al	As	Ba	Cd	Cr	Cu	Fe	Mg	Mn	Mo	Ni	Pb	Zn
37A	27100	<8	97.4	1.1	87.2	182	36900	12200	448	<0.8	33	138	223
	27400	20	99.2	1.1	98.1	185	35900	12200	450	<0.8	31	137	235
	28000	<8	97.7	1.0	104.0	184	36400	12200	455	<0.8	32	145	233
37B	26700	<8	92.7	0.4	76.1	178	40300	11800	452	<0.8	31	134	218
	27300	<8	96.8	0.3	72.4	176	39500	12200	442	<0.8	29	136	208
	26000	<8	86.3	0.4	60.7	161	39300	11600	397	2.1	24	116	185
37C	26300	<8	93.6	0.4	62.3	181	42700	11100	408	<0.8	24	131	220
	26200	<8	92.8	0.3	65.6	176	41600	11000	418	<0.8	25	123	211
	26400	<8	93.7	0.7	70.6	184	40300	11300	437	<0.8	28	131	231
39A	28500	<8	79.3	0.3	161.0	85	35200	12300	289	23.6	20	93	258
	30900	30	109.0	0.4	157.0	283	34300	11900	431	7.2	31	132	369
	29200	<8	74.6	0.3	59.3	61	34400	12300	259	36.6	18	73	186
39B	30400	44	124.0	0.6	141.0	118	35300	13200	444	<0.8	30	111	339
	30300	<8	84.7	0.3	78.2	75	35100	12700	290	32.9	20	84	237
39C	29300	17	106.0	0.3	91.3	92	34800	12700	397	16.7	24	75	279
	29700	36	115.0	0.3	94.6	83	34500	13600	449	12.4	27	66	243
	29200	<8	72.5	0.5	47.0	52	37200	12600	253	37.7	16	68	157
39D	27100	<6	132.0	1.3	139.0	141	38200	12000	510	<0.8	30	110	377
	27100	54	126.0	0.8	131.0	132	37700	11900	494	<0.8	29	100	359
	26300	<8	85.1	0.5	59.8	155	41000	12300	408	<0.8	26	137	202

APPENDIX IIIC RAW DATA OF SEDIMENT TRACE METAL CONCENTRATIONS - NOVEMBER 1985 (concluded)

	CONCENTRATION (µg/g dry weight)												
STATION	Al	As	Ba	Cd	Cr	Cu	Fe	Mg	Mn	Mo	Ni	Pb	Zn
39E	25600	<8	84.6	0.5	69.3	159	36400	11700	407	<0.8	25	128	210
	25400	<8	84.0	0.7	69.6	163	36200	11200	398	<0.8	26	130	221
	26900	<8	83.0	0.4	60.1	148	37600	11300	379	4.3	23	122	188
40	29100	<8	67.0	0.4	70.4	58	35900	12800	232	32.2	18	85	400
	29200	51	149.0	1.2	169.0	133	36200	12700	457	<0.8	33	135	417
	28100	31	103.0	0.3	157.0	105	36700	12500	401	6.9	27	108	347
41	28200	51	119.0	2.0	286.0	132	33600	11500	453	<0.8	29	163	456
	29300	45	130.0	3.3	310.0	188	35900	12000	478	<0.8	31	232	550
	30200	14	105.0	0.4	204.0	109	34800	12100	389	25.1	27	152	377

APPENDIX IIID **RAW DATA OF SEDIMENT TRACE METAL CONCENTRATIONS - JANUARY 1986**

STATION	CONCENTRATION (µg/g dry weight) Al	As	Ba	Cd	Cr	Cu	Fe	Mg	Mn	Mo	Ni	Pb	Zn
PEI	27100	<8	105.0	0.43	58.4	162	41300	14900	526	<0.8	42	42	148
	27800	<8	107.0	0.43	58.3	160	41900	15200	530	<0.8	43	44	147
	26500	<8	101.0	0.43	57.6	160	41200	14700	525	<0.8	42	37	148
11B	19100	<8	71.8	0.80	35.2	312	29400	8490	362	<0.8	23	62	196
	19500	<8	71.8	0.82	35.1	310	29600	8560	365	<0.8	23	69	185
	19500	<8	70.9	0.72	34.6	318	29300	8430	362	<0.8	22	64	179
15	20500	<8	80.2	0.79	40.8	466	31800	9670	383	<0.8	32	81	234
	22100	<8	83.8	0.81	46.2	500	34000	10400	401	<0.8	35	92	239
	21400	<8	81.3	0.67	41.3	429	32100	10100	392	<0.8	29	82	231
18	24000	<8	94.9	0.57	41.1	285	32800	10400	411	<0.8	27	75	180
	22400	<8	86.8	0.58	39.2	278	30600	9790	391	<0.8	27	70	179
	21200	<8	86.7	0.57	38.7	275	30400	9530	384	<0.8	26	67	177
19	20700	<8	77.7	0.68	38.0	293	30600	9020	377	<0.8	26	64	171
	20600	<8	75.7	0.67	38.3	279	30300	9090	376	<0.8	24	68	171
	22600	<8	90.8	0.64	39.7	314	32000	9840	396	<0.8	27	67	176
35	27600	<8	104.0	0.99	65.1	192	42700	12100	426	<0.8	28	104	222
	25800	<8	93.0	0.97	66.7	174	36500	11600	397	<0.8	27	96	203
	24700	<8	89.2	0.90	64.5	170	37000	11100	395	<0.8	26	91	193
38	23000	<8	95.9	1.45	100.0	147	37100	12600	408	<0.8	44	109	237

APPENDIX IIIB RAW DATA OF SEDIMENT TRACE METAL CONCENTRATIONS - MAY 1986

STATION	CONCENTRATION (μg/g dry weight)																
	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	V	Zn
PEI	24900	25	92.7	0.26	17.1	71.5	215	45300	0.233	13900	558	<0.8	52	59	6	72.0	95.7	164
	25200	31	91.7	0.23	13.7	64.7	212	45200	0.235	14200	564	<0.8	49	65	<2	73.1	95.4	166
	25800	27	95.8	0.29	17.9	65.9	183	45500	0.257	14900	553	<0.8	52	53	8	71.3	99.4	163
11B	17900	9	66.8	0.80	9.8	40.6	319	34200	0.217	8240	392	<0.8	27	72	5	64.4	93.1	194
	16800	15	58.9	0.54	11.9	38.6	296	33900	0.176	7850	386	<0.8	24	73	3	61.7	89.9	189
	16300	9	55.6	1.20	8.9	38.4	320	33700	0.181	7760	378	<0.8	25	64	4	59.7	88.0	191
15	17700	21	66.3	0.65	13.4	42.6	383	34200	0.269	8280	398	<0.8	33	80	7	62.3	85.3	198
	16800	14	63.5	0.81	9.1	40.5	366	33500	0.467	7980	391	<0.8	31	72	4	58.2	82.1	208
	16200	23	60.5	0.63	7.9	39.5	364	33000	0.284	7760	382	<0.8	26	73	10	56.6	81.9	201
16	16900	66	65.9	0.60	4.8	40.6	275	34500	0.244	7970	398	<0.8	27	72	10	58.7	84.1	202
	19600	75	75.0	0.98	11.9	49.1	341	38600	0.284	9360	447	<0.8	37	89	12	67.1	91.0	221
	16800	62	61.8	0.67	9.1	42.5	258	34300	1.160	7890	392	<0.8	31	73	2	56.3	81.2	193
19	20600	26	86.4	0.70	12.1	45.3	308	35500	0.285	9740	429	<0.8	32	85	4	71.8	87.9	220
	20800	33	80.4	0.60	11.3	45.5	332	36100	0.273	9980	435	<0.8	30	90	6	70.8	87.5	200
	21000	21	82.8	0.70	14.0	46.6	331	36200	0.235	9910	439	<0.8	34	89	7	72.0	87.5	202
35	25900	90	90.0	0.68	13.9	87.9	164	46900	0.414	11300	483	<0.8	37	134	9	81.5	98.2	231
	25900	91	90.7	0.92	10.1	86.8	164	46200	0.468	11400	483	<0.8	37	124	11	82.2	97.9	234
	25100	87	87.3	0.92	7.0	83.8	158	46700	0.494	11300	478	<0.8	37	120	12	82.4	96.8	221
38	26500	89	88.8	1.00	8.8	113.0	140	43600	0.469	11600	457	<0.8	40	132	5	80.2	98.4	241
	29100	100	100.0	1.00	11.6	116.0	146	45900	0.487	12100	500	<0.8	47	146	11	89.6	112.0	258
	28000	96	95.9	0.80	11.2	109.0	144	47700	0.488	11900	487	<0.8	45	146	5	87.0	105.0	254

APPENDIX IIIF RAW DATA OF SEDIMENT TRACE METAL CONCENTRATIONS - JUNE 1986

STATION	CONCENTRATION ($\mu g/g$ dry weight)																	
	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	V	Zn
1	15300	148	61.9	6.70	29.7	38.7	328	102000	0.153	6270	262	<0.8	203	13000	<2	57.0	106.0	2210
	11100	39	30.2	3.80	28.0	38.9	8890	58200	0.159	4220	229	<0.8	404	30000	<2	72.6	105.0	3050
	14900	102	55.9	5.00	31.1	37.9	3030	86600	0.159	6120	256	<0.8	280	3260	<2	64.3	153.0	1540
2	19700	<8	75.9	2.40	13.5	51.2	4000	42800	0.192	7690	309	<0.8	89	616	<2	86.1	143.0	586
	14700	20	59.7	2.50	12.5	61.6	4870	56000	0.109	6010	284	<0.8	90	628	<2	192.0	204.0	708
	12500	22	47.8	2.20	12.9	70.3	4190	66700	0.066	4990	275	<0.8	85	510	<2	193.0	262.0	669
20A	26400	<8	107.0	0.45	13.7	32.3	5.2	30400	0.227	9220	423	<0.8	19	77	11	76.6	83.2	130
	26900	<8	107.0	0.57	12.9	33.3	87.4	31200	0.198	9700	424	<0.8	20	64	6	78.9	85.1	130
	26900	<8	107.0	0.54	10.3	33.7	97.7	31300	0.217	9960	429	<0.8	20	66	8	81.5	84.6	134
20B	19400	<8	70.2	0.89	11.5	31.9	167	28500	0.255	8360	339	<0.8	21	58	7	64.8	78.2	139
	20200	10	73.2	0.65	16.9	33.5	170	28800	0.190	8690	344	<0.8	21	62	5	69.6	80.2	134
	20600	<8	76.0	0.46	12.2	33.3	167	29000	0.339	8790	347	<0.8	23	60	8	69.6	81.1	130
21A	21500	16	101.0	1.10	13.2	47.7	341	34900	0.229	10300	374	<0.8	84	162	14	88.5	115.0	303
	21900	14	92.0	1.04	9.0	45.9	357	33900	0.375	10200	366	<0.8	54	140	13	84.1	92.4	295
	20800	<8	89.6	1.60	6.6	42.5	364	32100	0.288	9730	349	<0.8	58	131	12	76.4	85.9	279
21B	17800	15	72.7	0.85	10.8	39.9	356	32200	0.197	8150	317	<0.8	47	119	11	69.0	99.7	232
	21900	<8	88.4	0.86	6.0	43.5	329	34100	0.251	9950	362	<0.8	40	106	8	86.3	94.3	228
	20900	9	85.1	0.86	10.1	44.1	324	34300	0.382	9710	360	<0.8	40	110	5	80.8	97.7	265
21C	21300	<8	86.4	0.79	10.4	42.8	406	33500	0.309	9430	364	<0.8	31	88	6	77.1	99.2	224
	22000	<8	86.4	0.90	12.5	41.6	392	31500	0.246	9900	358	<0.8	36	95	8	76.1	86.1	218
	21800	<8	81.4	0.90	9.1	41.7	408	31700	0.219	9640	356	<0.8	35	88	8	75.7	88.6	230
22A	25300	<8	187.0	1.60	14.8	37.2	321	35200	0.431	10500	477	<0.8	21	134	16	81.0	96.3	329
	23100	<8	169.0	2.00	10.0	35.7	349	32700	0.470	9450	434	<0.8	23	179	17	75.1	91.4	373
	25300	12	208.0	1.30	13.2	38.2	315	35500	0.449	10900	486	<0.8	23	127	18	84.7	96.4	297

APPENDIX IIIF RAW DATA OF SEDIMENT TRACE METAL CONCENTRATIONS - JUNE 1986 (continued)

	CONCENTRATION (μg/g dry weight)																
STATION	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	V	Zn
22B	20000	<8	130.0	1.70	10.2	37.2	829	30900	0.278	8930	349	<0.8	25	124	12	71.3	82.4	392
	22100	8	128.0	1.60	15.7	41.4	941	33100	0.330	9780	373	<0.8	31	130	13	76.8	88.1	355
	20500	11	105.0	1.20	10.5	39.6	746	32200	0.285	9250	355	<0.8	27	107	16	75.9	89.3	341
22C	23400	<8	94.2	0.80	11.7	43.8	906	32700	0.254	11300	383	<0.8	32	105	16	78.1	83.4	256
	22000	13	89.2	0.80	14.1	42.0	909	31900	0.280	10400	367	<0.8	30	95	14	72.5	82.1	233
	21600	<8	86.9	0.85	11.0	41.4	762	31800	0.205	10200	366	<0.8	31	85	13	72.4	80.6	222
23	20400	8	94.6	1.20	9.1	40.8	995	29200	0.263	8790	324	<0.8	26	96	6	80.6	81.1	261
	20200	<8	94.2	1.30	15.5	38.8	1040	29700	0.564	8810	327	<0.8	26	86	7	80.6	82.8	277
	19800	<8	93.0	1.20	7.7	39.6	939	29500	0.252	8840	321	<0.8	26	82	8	75.7	83.6	291
24	22400	<8	93.4	0.87	7.6	42.0	423	29800	0.292	9720	348	<0.8	34	92	7	122.0	80.6	197
	22000	<8	95.5	0.87	13.4	42.7	456	30100	0.283	9580	347	<0.8	31	97	8	134.0	82.3	207
	22500	<8	99.9	1.00	9.7	41.0	476	29500	0.266	9480	345	<0.8	27	87	9	130.0	81.4	195
25A	19400	<8	102.0	1.50	9.6	53.9	367	28800	1.660	8620	294	<0.8	28	348	22	61.3	73.6	303
	15400	9	78.1	0.90	7.8	44.4	263	24400	2.500	6360	250	<0.8	24	313	19	53.8	70.8	248
	18300	<8	101.0	1.70	7.4	56.7	398	27400	9.630	8360	279	<0.8	30	367	19	68.1	73.8	326
25B	14100	<8	65.9	1.60	7.7	35.0	396	23200	0.541	6330	249	<0.8	21	253	11	50.6	65.0	256
	12200	<8	57.8	0.84	8.1	27.8	300	20400	1.270	5290	223	<0.8	19	225	8	42.2	59.6	232
	13800	<8	63.2	1.50	7.6	32.2	301	21900	0.210	5850	241	<0.8	36	244	10	43.1	61.9	257
25C	21100	<8	91.9	0.88	11.4	42.4	461	29600	0.446	9110	335	<0.8	29	147	7	73.0	80.1	250
	20500	<8	84.7	0.90	16.8	43.3	417	31100	0.432	9880	349	<0.8	30	116	8	71.7	77.1	238
	22100	9	91.6	0.88	11.9	43.9	426	31900	0.463	10100	358	<0.8	36	143	7	74.9	81.1	222
26	17800	<8	77.3	1.70	19.9	34.4	506	27500	0.619	8270	322	<0.8	60	98	10	57.4	74.8	213
	19900	<8	85.4	0.82	13.0	40.0	526	29700	0.522	9260	346	<0.8	44	92	8	68.7	78.4	206
	18500	9	86.3	0.70	14.2	35.6	601	28000	0.305	8390	324	<0.8	58	99	9	63.6	75.5	207

APPENDIX IIIF RAW DATA OF SEDIMENT TRACE METAL CONCENTRATIONS - JUNE 1986 (concluded)

STATION	CONCENTRATION (µg/g dry weight)																
	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	V	Zn
27	22200	<8	102.0	0.96	15.7	43.6	370	33500	0.326	10700	389	<0.8	32	118	9	101.0	84.1	254
28	20300	10	115.0	1.50	11.3	41.6	444	30200	0.200	9070	346	<0.8	27	188	13	69.7	80.5	403
	19000	25	102.0	1.20	13.9	41.4	430	31000	0.489	9110	338	<0.8	28	168	9	67.4	75.7	343
	19200	32	96.3	1.40	15.6	42.0	429	31000	0.800	8830	333	<0.8	30	187	19	65.7	76.4	375
29	18300	<8	81.2	1.40	12.5	35.9	366	28100	0.262	8490	329	<0.8	26	88	13	65.6	77.2	218
	20000	<8	80.0	0.83	8.5	37.7	366	29200	0.309	9060	345	<0.8	27	84	8	64.3	77.7	214
	17200	10	73.5	0.79	14.0	32.8	325	26700	0.287	7970	313	<0.8	26	77	10	57.1	73.5	200
30	16700	<8	80.1	1.00	15.5	34.7	378	26000	0.432	7820	305	<0.8	24	110	8	59.2	69.6	261
	18300	10	98.0	1.20	6.3	35.1	384	26600	0.362	7860	310	<0.8	26	108	13	68.5	73.0	330
	17000	13	91.3	1.10	6.9	32.7	491	25700	5.870	7380	296	<0.8	32	129	10	68.3	71.3	348
31	13700	<8	50.6	0.42	8.8	33.1	193	30400	0.121	5940	257	<0.8	14	50	8	123.0	103.0	120
	14400	10	51.2	0.30	7.1	33.7	163	31500	0.133	6350	272	<0.8	17	43	6	71.0	98.8	107

APPENDIX IIIG RAW DATA OF SEDIMENT TRACE METAL CONCENTRATIONS - SEPTEMBER 1986

	CONCENTRATION (µg/g dry weight)																	
STATION	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	V	Zn
ATK	28900	<8	110.0	0.70	15.5	59.1	232	40700	0.244	14200	506	<0.8	43	69	6	78.1	96.2	156
	28000	<8	102.0	0.28	12.2	55.6	253	38500	0.289	14200	480	<0.8	41	67	6	79.9	93.3	160
	27900	18	102.0	0.60	13.0	55.7	237	39000	0.247	14100	487	<0.8	42	65	5	77.3	92.7	148
PEI	29700	<8	117.0	0.70	16.7	59.5	220	39200	0.208	14300	486	<0.8	45	70	10	77.1	99.4	155
	27500	<8	107.0	0.26	12.5	57.5	216	38800	0.257	13400	472	<0.8	43	63	8	75.0	95.3	154
	27400	37	104.0	0.70	17.3	55.9	146	39800	0.219	13700	516	<0.8	42	59	10	74.4	96.3	139
3A	25700	<8	99.0	7.40	11.3	48.4	1170	33400	0.277	11600	385	<0.8	34	278	<2	74.3	87.8	1240
	24900	<8	97.4	7.20	12.8	47.9	1170	32800	0.336	10600	375	<0.8	35	249	<2	71.0	86.9	1230
	25000	8	97.3	7.70	12.4	47.4	1220	33300	0.305	10500	379	<0.8	35	238	<2	70.5	87.2	1370
3B	19300	<8	74.8	6.10	12.0	47.4	1490	37200	0.180	7670	312	<0.8	33	228	<2	97.5	122.0	1100
	17800	<8	70.1	6.30	8.1	46.1	2140	39200	0.177	7030	304	<0.8	47	244	<2	89.6	125.0	1200
	18000	13	79.3	7.40	11.9	47.7	2270	40000	0.180	6930	305	<0.8	52	315	<2	86.9	127.0	1480
4B	19000	<8	70.8	4.40	10.1	41.6	1650	33600	0.307	7520	322	<0.8	39	159	<2	75.0	100.0	863
	19900	<8	78.0	4.80	10.7	41.8	1300	32600	0.222	8300	327	<0.8	36	192	4	70.9	95.0	904
	21800	<8	85.8	4.30	9.7	44.7	1310	34700	0.265	9780	357	<0.8	41	213	3	77.0	95.2	717
11B	16400	<8	52.7	0.54	3.9	27.0	217	24800	0.114	6530	302	<0.8	15	53	7	62.0	79.4	146
	17900	<8	59.8	0.45	4.9	31.4	218	28100	0.133	7670	326	<0.8	17	62	6	68.9	82.5	131
	11700	<8	30.9	0.33	4.6	20.1	107	22000	0.050	4610	251	<0.8	7	30	2	49.2	75.1	71
14	18600	<8	69.1	0.55	3.7	34.8	300	28900	0.702	7410	347	<0.8	22	64	2	68.0	83.5	148
	15900	<8	57.2	0.61	5.3	31.4	353	26500	0.145	6220	315	<0.8	24	59	4	61.3	80.4	168
	17100	<8	60.9	0.52	6.7	31.7	346	26800	0.133	6640	319	<0.8	20	68	4	64.7	81.4	149

APPENDIX IIIG - RAW DATA OF SEDIMENT TRACE METAL CONCENTRATIONS - SEPTEMBER 1986

	CONCENTRATION (μg/g dry weight)																
STATION	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	V	Zn
15	19100	<8	65.1	0.60	8.3	37.4	405	30100	0.186	8910	347	<0.8	29	79	4	68.2	85.5	167
	19200	<8	70.9	0.70	9.7	42.7	325	33200	0.209	9470	386	<0.8	31	81	6	71.3	84.2	186
	20900	<8	76.5	0.58	7.0	45.1	326	34000	0.241	10000	399	<0.8	32	86	5	76.6	85.6	180
16	13900	<8	47.1	0.52	5.0	25.0	189	23000	0.196	5960	270	<0.8	16	48	4	50.6	69.6	115
	13900	<8	46.2	0.50	5.3	26.3	189	23500	-	6210	271	<0.8	15	51	<2	49.4	71.5	109
	14200	<8	44.3	0.31	4.5	26.0	194	24100	0.127	5980	276	<0.8	14	43	4	52.8	75.7	95
17	19200	<8	72.9	0.41	9.0	34.3	231	26500	0.257	8230	330	<0.8	22	67	9	69.2	75.0	134
	20200	<8	75.7	0.60	13.9	37.2	269	29000	0.384	8960	355	<0.8	29	78	8	68.8	79.0	156
	21700	<8	83.0	0.60	13.8	40.3	274	30100	0.303	9480	370	<0.8	28	84	5	73.3	81.9	151
19	21500	<8	78.8	0.70	14.2	40.8	287	31200	0.228	9400	371	<0.8	31	80	1	74.7	83.4	159
	21000	<8	75.9	0.80	12.3	38.4	291	30600	0.236	9500	364	<0.8	26	84	7	71.9	60.9	154
	20600	<8	73.4	0.39	11.4	37.9	271	31200	0.245	9000	352	<0.8	25	79	8	72.8	81.9	145
35	28300	12	96.3	0.80	8.3	72.8	161	36200	0.402	11700	403	<0.8	31	116	6	85.2	91.6	182
	29600	17	100.0	0.80	9.9	75.5	176	37900	0.397	12300	421	<0.8	31	118	6	87.5	94.1	192
	29800	15	101.0	1.00	10.7	72.8	178	37600	0.413	12200	412	<0.8	31	120	5	89.4	93.6	191
38	28300	25	93.7	1.10	9.8	84.0	156	38100	0.412	11900	402	<0.8	33	129	8	85.6	92.9	214
	28400	9	94.5	0.90	9.3	80.4	160	37800	0.402	12000	397	<0.8	31	126	8	84.3	92.0	211
	29500	27	100.0	1.10	10.9	78.2	155	38900	-	12300	400	<0.8	32	140	8	88.0	94.3	243

APPENDIX IV

DESCRIPTIVE STATISTICS OF SEDIMENT TRACE METAL CONCENTRATIONS

A. MAY 1985
B. OCTOBER 1985
C. NOVEMBER 1985
D. JANUARY 1986
E. MAY 1986
F. JUNE 1986
G. SEPTEMBER 1986

APPENDIX IVA DESCRIPTIVE STATISTICS OF SEDIMENT TRACE METAL CONCENTRATIONS - MAY 1985

		CONCENTRATION (ug/g dry weight)													
STATION	STATISTIC	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
SB	MEAN(3)	24267	-	74.6	<0.3	50.4	65.1	38500	0.140	12533	456	-	39	17	108
	S.D.	351	-	2.3	-	0.5	0.5	100	0.014	153	8	-	1	3	4
	C.V.(%)	1	-	3	-	1	1	0	10	1	2	-	1	15	4
	MAX.	24600	<8	76.0	<0.3	50.9	65.5	38600	0.149	12700	463	<0.8	39	20	112
	MIN.	23900	<8	71.9	<0.3	49.9	64.6	38400	0.123	12400	448	<0.8	38	15	105
PEI	MEAN(3)	27533	-	82.3	<0.3	51.7	213.0	41033	0.240	12767	450	-	38	40	144
	S.D.	58	-	1.1	-	0.7	5.6	586	0.027	58	14	-	1	2	2
	C.V.(%)	0	-	1	-	1	3	1	11	0	3	-	2	5	1
	MAX.	27600	<8	83.4	<0.3	52.2	219.0	41700	0.267	12800	463	<0.8	39	42	145
	MIN.	27500	<8	81.3	<0.3	50.9	208.0	40600	0.213	12700	436	<0.8	38	38	142
11B	MEAN(3)	12400	-	31.2	<0.3	25.3	131.0	31767	0.092	4143	252	-	9	20	94
	S.D.	1082	-	8.0	-	4.3	4.0	4500	0.023	527	20	-	3	4	13
	C.V.(%)	9	-	26	-	17	3	14	25	13	8	-	34	20	13
	MAX.	13600	<8	40.2	<0.3	29.1	135.0	35300	0.114	4750	273	<0.8	13	25	107
	MIN.	11500	<8	25.1	<0.3	20.6	127.0	26700	0.069	3800	233	<0.8	7	18	82
16	MEAN(3)	22600	-	71.8	0.3	37.1	316.0	32267	0.423	8887	341	-	26	64	183
	S.D.	721	-	1.9	0.1	1.7	27.9	1026	0.086	466	13	-	1	4	12
	C.V.(%)	3	-	3	33	5	9	3	20	5	4	-	4	6	6
	MAX.	23400	<8	73.9	0.4	39.0	348.0	33400	0.508	9400	355	<0.8	27	68	194
	MIN.	22000	<8	70.1	0.3	35.6	297.0	31400	0.337	8490	329	<0.8	25	60	171
19	MEAN(3)	22867	-	72.2	<0.3	35.1	255.3	32800	0.283	8403	342	-	23	60	153
	S.D.	473	-	1.7	-	1.3	15.5	1082	0.020	96	8	-	2	1	11
	C.V.(%)	2	-	2	-	4	6	3	7	1	2	-	10	1	7
	MAX.	23400	<8	74.1	<0.3	36.4	273.0	34000	0.300	8490	351	<0.8	26	60	162
	MIN.	22500	<8	70.9	<0.3	33.9	244.0	31900	0.261	8300	336	<0.8	22	59	141

APPENDIX IVA DESCRIPTIVE STATISTICS OF SEDIMENT TRACE METAL CONCENTRATIONS - MAY 1985 (continued)

		CONCENTRATION (ug/g dry weight)													
STATION	STATISTIC	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
CP	MEAN(3)	12533	-	32.5	<0.3	28.5	63.8	36400	0.105	4023	268	-	7	19	88
	S.D.	252	-	1.6	-	10.2	8.7	13917	0.014	195	33	-	1	4	22
	C.V.(%)	2	-	5	-	36	14	38	13	5	12	-	8	22	25
	MAX.	12800	<8	34.1	<0.3	40.2	73.1	52400	0.119	4160	306	<0.8	8	24	113
	MIN.	12300	<8	31.0	<0.3	21.1	55.9	27100	0.091	3800	246	<0.8	7	16	70
BR	MEAN(3)	20633	-	59.7	0.5	29.9	152.3	28133	0.270	7513	310	-	18	48	131
	S.D.	321	-	1.6	0.2	0.8	2.9	503	0.019	289	7	-	1	3	6
	C.V.(%)	2	-	3	40	3	2	2	7	4	2	-	6	5	5
	MAX.	21000	<8	60.8	0.6	30.6	154.0	28600	0.289	7700	316	<0.8	19	50	135
	MIN.	20400	<8	57.9	0.3	29.0	149.0	27600	0.251	7180	303	<0.8	17	45	124
32	MEAN(3)	26600	-	80.9	0.4	47.7	190.0	36033	0.420	10250	368	-	25	75	165
	S.D.	1389	-	1.0	0.1	4.1	9.8	3075	0.030	786	28	-	2	5	13
	C.V.(%)	5	-	1	25	9	5	9	7	8	8	-	8	7	8
	MAX.	27500	<8	81.9	0.4	50.5	198.0	38100	0.455	10800	386	<0.8	27	79	174
	MIN.	25000	<8	80.0	0.3	43.0	179.0	32500	0.402	9350	336	<0.8	23	69	151
33B	MEAN(3)	25333	-	88.8	0.5	47.7	213.7	49900	0.267	9580	344	-	24	84	239
	S.D.	231	-	0.8	0.1	1.4	23.7	4887	0.067	296	6	-	1	7	40
	C.V.(%)	1	-	1	20	3	11	10	25	3	2	-	2	8	17
	MAX.	25600	<8	89.7	0.6	49.2	241.0	55500	0.323	9920	349	<0.8	24	92	285
	MIN.	25200	<8	88.1	0.4	46.5	200.0	46500	0.193	9380	338	<0.8	23	80	211
34	MEAN(3)	28167	-	82.7	0.4	59.2	180.3	39133	0.415	11100	374	-	27	90	186
	S.D.	379	-	1.8	0.2	0.9	2.5	321	0.041	0.0	3	-	1	2	2
	C.V.(%)	1	-	2	50	1	1	1	10	0.0	1	-	2	2	1
	MAX.	28600	<8	84.4	0.6	60.0	183.0	39500	0.459	11100	377	<0.8	28	91	188
	MIN.	27900	<8	80.9	0.3	58.3	178.0	38900	0.378	11100	371	<0.8	27	88	184

APPENDIX IVA DESCRIPTIVE STATISTICS OF SEDIMENT TRACE METAL CONCENTRATIONS - MAY 1985 (concluded)

		CONCENTRATION (ug/g dry weight)													
STATION	STATISTIC	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
35	MEAN(3)	28833	-	82.5	0.6	66.0	167.3	38767	0.437	10900	363	-	28	96	194
	S.D.	987	-	3.8	0.1	0.9	4.0	1069	0.049	400	8	-	1	2	6
	C.V.(%)	3	-	5	17	1	2	3	11	4	2	-	2	2	3
	MAX.	29500	<8	86.2	0.7	66.6	171.0	39700	0.471	11300	369	<0.8	28	98	198
	MIN.	27700	<8	78.6	0.5	64.9	163.0	37600	0.381	10500	354	<0.8	27	94	187

NOTE: Single samples were taken from Stations 33A and 42-47. Refer to raw data (Appendix IIIA) for values.

APPENDIX IVB DESCRIPTIVE STATISTICS OF SEDIMENT TRACE METAL CONCENTRATIONS - OCTOBER 1985

		CONCENTRATION (ug/g dry weight)													
STATION	STATISTIC	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
PEI	MEAN(3)	25633	-	80.3	0.29	53.5	197	37933	0.28	14833	489	-	43	43	147
	S.D.	1724	-	6.3	0.01	1.5	10	1305	0.03	651	18	-	1	3	5
	C.V.(%)	7	-	8	4	3	5	3	12	4	4	-	2	7	3
	MAX.	27500	<8	87.2	0.30	55.2	206	39400	0.31	15500	507	<0.8	44	47	152
	MIN.	24100	<8	75.0	0.28	52.2	187	36900	0.26	14200	471	<0.8	42	41	143
DD	MEAN(3)	20400	-	63.5	0.81	50.4	504	41067	0.26	10410	400	-	35	67	206
	S.D.	3242	-	11.3	0.08	0.6	56	3717	0.05	2242	41	-	7	8	10
	C.V.(%)	16	-	18	10	1	11	9	19	22	10	-	19	12	5
	MAX.	23900	<8	76.0	0.88	51.0	561	43600	0.31	12900	445	<0.8	42	76	214
	MIN.	17500	<8	54.0	0.72	49.9	449	36800	0.21	8550	364	<0.8	29	61	195
11B	MEAN(3)	13767	-	48.7	0.59	40.2	191	44833	0.11	6047	333	-	14	40	141
	S.D.	737	-	5.4	0.03	8.4	15	9961	0.01	348	24	-	2	8	14
	C.V.(%)	5	-	11	4	21	8	22	12	6	7	-	11	19	10
	MAX.	14600	<8	52.4	0.62	47.3	207	52200	0.12	6420	353	<0.8	15	49	151
	MIN.	13200	<8	42.5	0.57	31.0	177	33500	0.10	5730	307	<0.8	12	35	125
16	MEAN(3)	18800	-	63.1	0.69	32.1	275	26233	0.34	8480	335	-	22	59	150
	S.D.	917	-	4.6	0.13	0.8	13	208	0.14	226	4	-	1	5	19
	C.V.(%)	5	-	7	19	3	5	1	42	3	1	-	3	8	13
	MAX.	19600	<8	67.5	0.78	33.0	284	26400	0.49	8720	339	<0.8	22	63	168
	MIN.	17800	<8	58.3	0.54	31.5	260	26000	0.21	8270	331	<0.8	21	54	130
19	MEAN(3)	19700	-	69.1	0.59	34.2	300	27600	0.22	8840	346	-	23	61	151
	S.D.	1744	-	5.8	0.04	0.9	27	346	0.02	727	14	-	1	2	4
	C.V.(%)	9	-	8	6	3	9	1	11	8	4	-	4	4	2
	MAX.	21700	<8	75.0	0.63	35.1	331	27800	0.24	9630	361	<0.8	24	62	155
	MIN.	18500	<8	63.5	0.56	33.3	281	27200	0.20	8200	334	<0.8	22	58	148

APPENDIX IVB DESCRIPTIVE STATISTICS OF SEDIMENT TRACE METAL CONCENTRATIONS - OCTOBER 1985 (concluded)

		CONCENTRATION (ug/g dry weight)													
STATION	STATISTIC	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
35	MEAN(3)	25700	-	79.7	0.77	65.6	182	36800	0.49	12200	398	-	28	102	202
	S.D.	608	-	1.8	0.08	2.9	3	1400	0.03	346	8	-	1	3	2
	C.V.(%)	2	-	2	10	4	1	4	5	3	2	-	4	3	1
	MAX.	26100	<8	81.8	0.86	68.2	184	38200	0.52	12400	405	<0.8	29	106	203
	MIN.	25000	<8	78.4	0.72	62.4	179	35400	0.47	11800	390	<0.8	27	100	200

APPENDIX IVC DESCRIPTIVE STATISTICS OF SEDIMENT TRACE METAL CONCENTRATIONS - NOVEMBER 1985

		CONCENTRATION (ug/g dry weight)												
STATION	STATISTIC	Al	As	Ba	Cd	Cr	Cu	Fe	Mg	Mn	Mo	Ni	Pb	Zn
4A	MEAN(3)	23933	-	97.0	2.7	77.0	1206	34533	8730	340	-	37	162	1372
	S.D.	4576	-	34.6	2.7	30.7	970	1436	2581	108	-	10	47	1002
	C.V.(%)	19	-	36	99	40	80	4	30	32	-	26	29	73
	MAX.	29000	52	137.0	5.7	105.0	1830	35600	11600	464	29.8	45	193	2220
	MIN.	20100	<8	77.0	0.4	44.2	89	32900	6600	263	<0.8	26	108	266
5	MEAN(3)	24067	-	94.7	1.5	38.1	542	29567	9340	277	18.4	19	93	1172
	S.D.	1474	-	31.1	1.9	11.9	165	709	903	65	7.5	7	17	1168
	C.V.(%)	6	-	33	122	31	30	2	10	23	41	37	18	100
	MAX.	25200	23	130.0	3.7	51.8	685	30200	10200	348	27.0	27	112	2520
	MIN.	22400	<8	71.1	0.4	29.9	361	28800	8400	220	13.6	13	82	455
6	MEAN(3)	25867	-	107.1	0.9	53.0	439	31733	11167	365	-	23	97	519
	S.D.	702	-	25.3	0.6	19.7	143	208	611	91	-	5	22	169
	C.V.(%)	3	-	24	73	37	33	1	5	25	-	21	23	33
	MAX.	26600	33	136.0	1.6	75.5	604	31900	11700	470	25.3	28	122	711
	MIN.	25200	<8	89.4	0.5	39.0	346	31500	10500	312	<0.8	19	81	391
7A	MEAN(3)	24000	-	103.4	0.6	55.2	307	29833	9980	390	11.0	22	99	483
	S.D.	819	-	13.6	0.1	7.5	23	833	397	31	6.4	2	6	59
	C.V.(%)	3	-	13	10	14	7	3	4	8	58	9	6	12
	MAX.	24700	12	119.0	0.6	61.6	330	30500	10400	419	17.6	24	103	539
	MIN	23100	<8	94.0	0.5	47.0	285	28900	9610	357	4.9	20	93	422
7B	MEAN(3)	23667	-	84.1	0.4	42.2	247	30633	9727	306	-	19	72	316
	S.D.	58	-	40.4	0.1	25.5	146	252	119	150	-	10	20	181
	C.V.(%)	0	-	48	25	60	59	1	1	49	-	51	28	57
	MAX.	23700	33	116.0	0.5	60.5	369	30900	9810	417	34.7	26	89	472
	MIN.	23600	<8	38.7	0.3	13.1	85	30400	9590	135	<0.8	8	50	118
8	MEAN(3)	20533	-	109.7	0.4	39.9	242	27633	8080	301	12.3	17	88	646
	S.D.	1012	-	3.2	0.1	2.8	6	416	320	14	9.8	3	8	6
	C.V.(%)	5	-	3	13	7	3	2	4	5	79	18	9	1
	MAX.	21700	9	112.0	0.5	42.6	249	28100	8400	311	23.3	20	96	652
	MIN.	19900	<8	106.0	0.4	37.1	237	27300	7760	285	4.6	14	81	640

APPENDIX IVC DESCRIPTIVE STATISTICS OF SEDIMENT TRACE METAL CONCENTRATIONS - NOVEMBER 1985 (continued)

STATION	STATISTIC	CONCENTRATION (ug/g dry weight)												
		Al	As	Ba	Cd	Cr	Cu	Fe	Mg	Mn	Mo	Ni	Pb	Zn
9	MEAN(3)	22733	-	102.6	0.5	37.5	226	29100	9210	294	21.3	16	84	382
	S.D.	666	-	6.6	0.2	3.4	7	400	453	21	1.8	2	3	6
	C.V.(%)	3	-	6	33	9	3	1	5	7	8	11	3	2
	MAX.	23300	<8	109.0	0.6	39.9	234	29500	9690	313	23.3	18	87	389
	MIN.	22000	<8	95.9	0.3	33.6	220	28700	8790	272	20.0	15	82	377
10A	MEAN(3)	22167	-	95.0	0.7	47.3	233	29800	9033	348	-	20	73	338
	S.D.	379	-	16.0	0.2	16.5	70	755	234	85	-	6	10	94
	C.V.(%)	2	-	17	31	35	30	3	3	24	-	27	14	28
	MAX.	22600	32	110.0	0.9	65.9	308	30600	9240	442	25.3	26	82	404
	MIN.	21900	<8	78.2	0.5	34.3	169	29100	8780	275	<0.8	15	62	231
10B	MEAN(3)	23467	-	59.3	0.5	29.5	146	29733	9487	237	20.8	13	52	172
	S.D.	351	-	25.0	0.1	19.4	83	1106	348	106	15.2	7	12	90
	C.V.(%)	1	-	42	12	66	57	4	4	45	73	49	24	52
	MAX.	23800	<8	86.9	0.5	50.3	236	30900	9740	346	32.9	20	66	270
	MIN.	23100	<8	38.0	0.4	11.8	74	28700	9090	135	3.8	7	42	93
11A	MEAN(3)	17900	-	83.0	0.6	32.7	148	25900	6863	268	14.7	13	70	335
	S.D.	700	-	15.6	0.1	7.4	24	173	176	36	6.2	1	6	47
	C.V.(%)	4	-	19	10	23	16	1	3	14	42	8	8	14
	MAX.	18600	22	94.0	0.6	41.0	175	26000	6970	309	21.1	14	75	387
	MIN.	17200	<8	65.2	0.5	26.7	132	25700	6660	240	8.7	12	64	296
12	MEAN(3)	20967	-	90.3	0.6	49.6	159	35900	8400	334	20.6	15	77	310
	S.D.	1589	-	6.7	0.2	7.1	36	2594	852	33	17.2	2	27	80
	C.V.(%)	8	-	7	37	14	23	7	10	10	83	13	35	26
	MAX.	22800	17	96.1	0.8	56.9	186	38000	9380	360	38.5	17	108	402
	MIN.	20000	<8	82.9	0.4	42.7	118	33000	7830	297	4.2	13	59	256
13A	MEAN(3)	17367	-	71.2	0.6	74.5	143	50567	6910	385	-	13	57	256
	S.D.	1290	-	13.0	0.1	29.0	22	7601	791	109	-	3	6	31
	C.V.(%)	7	-	18	20	39	16	15	11	28	-	23	11	12
	MAX.	18800	<8	79.2	0.7	108.0	157	56100	7820	507	14.5	16	62	274
	MIN.	16300	<8	56.2	0.5	56.8	117	41900	6390	297	<0.8	10	50	220

APPENDIX IVC DESCRIPTIVE STATISTICS OF SEDIMENT TRACE METAL CONCENTRATIONS - NOVEMBER 1985 (continued)

STATION	STATISTIC	CONCENTRATION (ug/g dry weight) Al	As	Ba	Cd	Cr	Cu	Fe	Mg	Mn	Mo	Ni	Pb	Zn
13B	MEAN(3)	17100	-	57.1	0.4	39.1	115	35400	6600	276	16.5	10	39	161
	S.D.	2170	-	5.5	0.1	2.0	26	4513	1153	16	7.2	2	6	22
	C.V.(%)	13	-	10	25	5	23	13	17	6	43	17	16	14
	MAX.	18500	<8	60.7	0.5	40.9	133	40600	7460	291	24.1	11	44	180
	MIN.	14600	<8	50.8	0.3	36.9	85	32500	5290	259	9.9	8	32	137
36	MEAN(3)	26800	-	92.9	0.9	70.3	193	37500	12200	445	-	28	120	202
	S.D.	100	-	3.3	1.0	3.4	5	721	265	9	-	1	5	12
	C.V.(%)	0	-	4	106	5	3	2	2	2	-	4	4	6
	MAX.	26900	13	95.9	2.0	73.2	199	38300	12400	455	<0.8	29	125	211
	MIN.	26700	<8	89.3	0.3	66.6	189	36900	11900	437	<0.8	27	115	188
37A	MEAN(3)	27500	-	98.1	1.1	96.4	184	36400	12200	451	-	32	140	230
	S.D.	458	-	1.0	0.1	8.5	2	500	0	4	-	1	4	6
	C.V.(%)	2	-	1	5	9	1	1	0	1	-	3	3	3
	MAX.	28000	20	99.2	1.1	104.0	185	36900	12200	455	<0.8	33	145	235
	MIN.	27100	<8	97.4	1.0	87.2	182	35900	12200	448	<0.8	31	137	223
37B	MEAN(3)	26667	-	91.9	0.4	69.7	172	39700	11867	430	-	28	129	204
	S.D.	651	-	5.3	0.1	8.0	9	529	306	29	-	4	11	17
	C.V.(%)	2	-	6	16	12	5	1	3	7	-	13	9	8
	MAX.	27300	<8	96.8	0.4	76.1	178	40300	12200	452	2.1	31	136	218
	MIN.	26000	<8	86.3	0.3	60.7	161	39300	11600	397	<0.8	24	116	185
37C	MEAN(3)	26300	-	93.4	0.5	66.2	180	41533	11133	421	-	26	128	221
	S.D.	100	-	0.5	0.2	4.2	4	1201	153	15	-	2	5	10
	C.V.(%)	0	-	1	45	6	2	3	1	3	-	8	4	5
	MAX.	26400	<8	93.7	0.7	70.6	184	42700	11300	437	<0.8	28	131	231
	MIN.	26200	<8	92.8	0.3	62.3	176	40300	11000	408	<0.8	24	123	211
39A	MEAN(3)	29533	-	87.6	0.3	125.8	143	34633	12167	326	22.5	23	99	271
	S.D.	1234	-	18.7	0.1	57.6	122	493	231	92	14.7	7	30	92
	C.V.(%)	4	-	21	17	46	86	1	2	28	66	30	30	34
	MAX.	30900	30	109.0	0.4	161.0	283	35200	12300	431	36.6	31	132	369
	MIN.	28500	<8	74.6	0.3	59.3	61	34300	11900	259	7.2	18	73	186

APPENDIX IVC   DESCRIPTIVE STATISTICS OF SEDIMENT TRACE METAL CONCENTRATIONS - NOVEMBER 1985 (concluded)

STATION	STATISTIC	CONCENTRATION (ug/g dry weight) Al	As	Ba	Cd	Cr	Cu	Fe	Mg	Mn	Mo	Ni	Pb	Zn
39B	MEAN(2)	30350	-	104.4	0.5	109.6	96	35200	12950	367	-	25	98	288
	S.D.	71	-	27.8	0.2	44.4	31	141	354	109	-	7	19	72
	C.V.(%)	0	-	27	47	41	32	0	3	30	-	28	20	25
	MAX.	30400	44	124.0	0.6	141.0	118	35300	13200	444	32.9	30	111	339
	MIN.	30300	<8	84.7	0.3	78.2	75	35100	12700	290	<0.8	20	84	237
39C	MEAN(3)	29400	-	98	0	78	76	35500	12967	366	22.2	22	70	226
	S.D.	265	-	22.4	0.1	26.6	21	1480	551	102	13.5	6	5	63
	C.V.(%)	1	-	23	31	34	28	4	4	28	61	25	7	28
	MAX.	29700	36	115.0	0.5	94.6	92	37200	13600	449	37.7	27	75	279
	MIN.	29200	<8	72.5	0.3	47.0	52	34500	12600	253	12.4	16	66	157
39D	MEAN(3)	26833	-	114.4	0.9	109.9	143	38967	12067	471	-	28	116	313
	S.D.	462	-	25.5	0.4	43.6	12	1779	208	55	-	2	19	96
	C.V.(%)	2	-	22	47	40	8	5	2	12	-	7	17	31
	MAX.	27100	66	132.0	1.3	139.0	155	41000	12300	510	<0.8	30	137	377
	MIN.	26300	<8	85.1	0.5	59.8	132	37700	11900	408	<0.8	26	100	202
39E	MEAN(3)	25967	-	83.9	0.5	66.3	157	36733	11400	395	-	25	127	206
	S.D.	814	-	0.8	0.2	5.4	8	757	265	14	-	2	4	17
	C.V.(%)	3	-	1	29	8	5	2	2	4	-	6	3	8
	MAX.	26900	<8	84.6	0.7	69.6	163	37600	11700	407	4.3	26	130	221
	MIN.	25400	<8	83.0	0.4	60.1	148	36200	11200	379	<0.8	23	122	188
40	MEAN(3)	28800	-	106.3	0.6	132.1	99	36267	12667	363	-	26	109	388
	S.D.	608	-	41.1	0.5	53.8	38	404	153	117	-	8	25	37
	C.V.(%)	2	-	39	78	41	38	1	1	32	-	29	23	9
	MAX.	29200	51	149.0	1.2	169.0	133	36700	12800	457	32.2	33	135	417
	MIN.	28100	<8	67.0	0.3	70.4	58	35900	12500	232	<0.8	18	85	347
41	MEAN(3)	29233	37	118.0	1.9	266.7	143	34767	11867	440	-	29	182	461
	S.D.	1002	20	12.5	1.5	55.6	41	1150	321	46	-	2	43	87
	C.V.(%)	3	54	11	76	21	28	3	3	10	-	7	24	19
	MAX.	30200	51	130.0	3.3	310.0	188	35900	12100	478	25.1	31	232	550
	MIN.	28200	14	105.0	0.4	204.0	109	33600	11500	389	<0.8	27	152	377

APPENDIX IVD DESCRIPTIVE STATISTICS OF SEDIMENT TRACE METAL CONCENTRATIONS - JANUARY 1986

		CONCENTRATION (ug/g dry weight)												
STATION	STATISTIC	Al	As	Ba	Cd	Cr	Cu	Fe	Mg	Mn	Mo	Ni	Pb	Zn
PEI	MEAN(3)	27133	-	104.3	0.43	58.1	161	41467	14933	527	-	42	41	148
	S.D.	651	-	3.1	0	0.4	1	379	252	3	-	1	4	1
	CV(%)	2	-	2.9	0	0.8	1	1	2	1	-	1	9	0
	MAX.	27800	<8	107.0	0.43	58.4	162	41900	15200	530	<0.8	43	44	148
	MIN.	26500	<8	101.0	0.43	57.6	160	41200	14700	525	<0.8	42	37	147
11B	MEAN(3)	19367	-	71.5	0.78	35.0	313	29433	8493	363	-	23	65	187
	S.D.	231	-	0.5	0.05	0.3	4	153	65	2	-	1	4	9
	CV(%)	1	-	0.7	6.78	0.9	1	1	1	0	-	3	6	5
	MAX.	19500	<8	71.8	0.82	35.2	318	29600	8560	365	<0.8	23	69	196
	MIN.	19100	<8	70.9	0.72	34.6	310	29300	8430	362	<0.8	22	62	179
15	MEAN(3)	21333	-	81.8	0.76	42.8	465	32633	10057	392	-	32	85	235
	S.D.	802	-	1.8	0.08	3.0	36	1193	367	9	-	3	6	4
	CV(%)	4	-	2.3	10.01	7.0	8	4	4	2	-	9	7	2
	MAX.	22100	<8	83.8	0.81	46.2	500	34000	10400	401	<0.8	35	92	239
	MIN.	20500	<8	80.2	0.67	40.8	429	31800	9670	383	<0.8	29	81	231
18	MEAN(3)	22533	-	89.5	0.57	39.7	279	31267	9907	395	-	27	71	179
	S.D	1405	-	8.2	0.02	0.9	17	907	454	11	-	1	2	3
	CV(%)	6	-	9	3	2	6	3	5	3	-	4	3	2
	MAX.	24000	<8	94.9	0.58	41.1	285	32800	10400	411	<0.8	27	75	180
	MIN.	21200	<8	86.7	0.57	38.7	275	30400	9530	384	<0.8	26	67	177
19	MEAN(3)	21300	-	81.4	0.66	38.7	295	30967	9317	383	-	26	66	173
	S.D	1127	-	8.2	0.02	0.9	18	907	455	11	-	2	2	3
	CV(%)	5	-	10.1	3.14	2.3	6	3	5	3	-	6	3	2
	MAX.	22600	<8	90.8	0.68	39.7	314	32000	9840	396	<0.8	27	68	176
	MIN.	20600	<8	75.7	0.64	38.0	279	30300	9020	376	<0.8	24	64	171
35	MEAN(3)	26033	-	95.4	0.95	65.4	179	38733	11600	406	-	27	97	206
	S.D.	1464	-	7.7	0.05	1.1	12	3444	500	17	-	1	7	15
	CV(%)	6	-	8.1	5	2	7	9	4	4	-	4	7	7
	MAX.	27600	<8	104.0	0.99	66.7	192	42700	12100	426	<0.8	28	104	222
	MIN.	24700	<8	89.2	0.90	64.5	170	36500	11100	395	<0.8	26	91	193

NOTE: Station 38 was a single sample. Refer to raw data (Appendix IIID) for values.

APPENDIX IVE DESCRIPTIVE STATISTICS OF SEDIMENT TRACE METAL CONCENTRATIONS - MAY 1986

											CONCENTRATION (ug/g dry weight)								
STATION	STATISTIC	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	V	Zn
PEI	MEAN(3)	25300	28	93.4	0.26	16.2	67.4	203.3	45333	0.242	14333	558	-	51	59	-	72.1	96.8	164
	S.D.	458	3	2.1	0.03	2.2	3.6	17.7	153	0.013	513	6	-	2	6	-	0.9	2.2	2
	C.V.(%)	2	11	2	12	14	5	9	0	6	4	1	-	3	10	-	1	2	1
	MAX.	25800	31	95.8	0.29	17.9	71.5	215.0	45500	0.257	14900	564	<0.8	52	65	8	73.1	99.4	166
	MIN.	24900	25	91.7	0.23	13.7	64.7	183.0	45200	0.233	13900	553	<0.8	49	53	<2	71.3	95.4	163
11B	MEAN(3)	17000	11	60.4	0.85	10.2	39.2	311.7	33933	0.191	7950	385	-	25	70	4	61.9	90.3	191
	S.D.	819	3	5.8	0.33	1.5	1.2	13.6	252	0.022	255	7	-	2	5	1	2.4	2.6	3
	C.V.(%)	5	31	10	39	15	3	4	1	12	3	2	-	6	7	25	4	3	1
	MAX.	17900	15	66.8	1.20	11.9	40.6	320.0	34200	0.217	8240	392	<0.8	27	73	5	64.4	93.1	194
	MIN.	16300	9	55.6	0.54	8.9	38.4	296.0	33700	0.176	7760	378	<0.8	24	64	3	59.7	88.0	189
15	MEAN(3)	16900	19	63.4	0.70	10.1	40.9	371.0	33567	0.340	8007	390	-	30	75	7	59.1	83.1	202
	S.D.	755	5	2.9	0.10	2.9	1.6	10.4	603	0.110	261	8	-	4	4	3	2.9	1.9	5
	C.V.(%)	4	24	5	14	29	4	3	2	32	3	2	-	12	6	43	5	2	3
	MAX.	17700	23	66.3	0.81	13.4	42.6	383.0	34200	0.467	8280	398	<0.8	33	80	10	62.3	85.3	208
	MIN.	16200	14	60.5	0.63	7.9	39.5	364.0	33000	0.269	7760	382	<0.8	26	72	4	56.8	81.9	198
16	MEAN(3)	17767	25	67.6	0.75	8.6	44.1	291.3	35800	0.563	8407	412	-	32	78	8	60.7	85.4	205
	S.D.	1589	5	6.8	0.20	3.6	4.5	43.8	2427	0.518	827	30	-	5	10	5	5.7	5.0	14
	C.V.(%)	9	18	10	27	42	10	15	7	92	10	7	-	16	12	66	9	6	7
	MAX.	19600	28	75.0	0.98	11.9	49.1	341.0	38600	1.160	9360	447	<0.8	37	89	12	67.1	91.0	221
	MIN.	16800	20	61.8	0.60	4.8	40.6	258.0	34300	0.244	7890	392	<0.8	27	72	2	56.3	81.2	193
19	MEAN(3)	20800	27	83.2	0.67	12.5	45.8	323.7	35933	0.264	9877	434	-	32	88	6	71.5	87.6	207
	S.D.	200	6	3.0	0.06	1.4	0.7	13.6	379	0.026	123	5	-	2	3	2	0.6	0.2	11
	C.V.(%)	1	23	4	9	11	2	4	1	10	1	1	-	6	3	27	1	0	5
	MAX.	21000	33	86.4	0.70	14.0	46.6	332.0	36200	0.285	9980	439	<0.8	34	90	7	72.0	87.9	220
	MIN.	20600	21	80.4	0.60	11.3	45.3	308.0	35500	0.235	9740	429	<0.8	30	85	4	70.8	87.5	200

APPENDIX IVE DESCRIPTIVE STATISTICS OF SEDIMENT TRACE METAL CONCENTRATIONS - MAY 1986 (concluded)

		CONCENTRATION (ug/g dry weight)																
STATION	STATISTIC	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	V	Zn
35	MEAN(3)	25633	36	89.3	0.84	10.3	86.2	162.0	46600	0.459	11333	481	-	37	126	11	82.0	97.6	229
	S.D.	462	8	1.8	0.14	3.5	2.1	3.5	361	0.041	58	3	-	0	7	2	0.5	0.7	7
	C.V.(%)	2	23	2	16	33	2	2	1	9	1	1	-	0	6	14	1	1	3
	MAX.	25900	43	90.7	0.92	13.9	87.9	164.0	46900	0.494	11400	483	<0.8	37	134	12	82.4	98.2	234
	MIN.	25100	27	87.3	0.68	7.0	83.8	158.0	46200	0.414	11300	478	<0.8	37	120	9	81.5	96.8	221
38	MEAN(3)	27867	40	94.9	0.93	10.5	112.7	143.3	46733	0.481	11867	481	-	44	141	7	85.6	105.1	251
	S.D	1305	14	5.7	0.12	1.5	3.5	3.1	2779	0.011	252	22	-	4	8	3	4.9	6.8	9
	C.V.(%)	5	35	6	12	14	3	2	6	2	2	5	-	8	6	49	6	6	4
	MAX.	29100	55	100.0	1.00	11.6	116.0	146.0	48900	0.488	12100	500	<0.8	47	146	11	89.6	112.0	258
	MIN.	26500	28	88.8	0.80	8.8	109.0	140.0	43600	0.469	11600	457	<0.8	40	132	5	80.2	98.4	241

APPENDIX IVF DESCRIPTIVE STATISTICS OF SEDIMENT TRACE METAL CONCENTRATIONS - JUNE 1986

		CONCENTRATION (ug/g dry weight)																	
STATION	STATISTIC	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	V	Zn
1	MEAN(3)	13767	96	49.3	5.17	29.6	38.5	4083	82267	0.157	5537	249	-	296	15420	-	64.6	121.3	2267
	S.D.	2318	55	16.8	1.46	1.6	0.5	4377	22219	0.003	1143	18	-	101	13533	-	7.8	27.4	757
	C.V.(%)	17	57	34	28	5	1	107	27	2	21	7	-	34	88	-	12	23	33
	MAX.	15300	148	61.9	6.70	31.1	38.9	8890	102000	0.159	6270	262	<0.8	404	30000	<2	72.6	153.0	3050
	MIN.	11100	39	30.2	3.80	28.0	37.9	328	58200	0.153	4220	229	<0.8	203	3260	<2	57.0	105.0	1540
2	MEAN(3)	15633	-	61.1	2.37	13.0	61.0	4353	55167	0.122	6230	289	-	88	585	-	157.0	203.0	654
	S.D.	3690	-	14.1	0.15	0.5	9.6	457	11972	0.064	1363	18	-	3	65	-	61.4	59.5	62
	C.V.(%)	24	-	23	6	4	16	11	22	52	22	6	-	3	11	-	39	29	10
	MAX.	19700	22	75.9	2.50	13.5	70.3	4870	66700	0.192	7690	309	<0.8	90	628	<2	193.0	262.0	708
	MIN.	12500	<8	47.8	2.20	12.5	51.2	4000	42800	0.066	4990	275	<0.8	85	510	<2	86.1	143.0	586
20A	MEAN(3)	26733	-	107.0	0.52	12.3	33.1	90	30967	0.214	9627	425	-	20	69	8	79.0	84.3	131
	S.D.	289	-	0.0	0.06	1.8	0.7	7	493	0.015	375	3	-	1	7	3	2.5	1.0	2
	C.V.(%)	1	-	0	12	14	2	7	2	7	4	1	-	3	10	30	3	1	2
	MAX.	26900	<8	107.0	0.57	13.7	33.7	98	31300	0.227	9960	429	<0.8	20	77	11	81.5	85.1	134
	MIN.	26400	<8	107.0	0.45	10.3	32.3	85	30400	0.198	9220	423	<0.8	19	64	6	76.6	83.2	130
20B	MEAN(3)	20067	-	73.1	0.67	13.5	32.9	168	28767	0.261	8613	343	-	22	60	7	68.0	79.8	134
	S.D.	611	-	2.9	0.22	2.9	0.9	2	252	0.075	225	4	-	1	2	2	2.8	1.5	5
	C.V.(%)	3	-	4	32	22	3	1	1	29	3	1	-	5	3	23	4	2	3
	MAX.	20600	10	76.0	0.89	16.9	33.5	170	29000	0.339	8790	347	<0.8	23	62	8	69.6	81.1	139
	MIN.	19400	<8	70.2	0.46	11.5	31.9	167	28500	0.190	8360	339	<0.8	21	58	5	64.8	78.2	130
21A	MEAN(3)	21400	-	94.2	1.25	9.6	45.4	354	33633	0.297	10077	363	-	65	144	13	83.0	97.8	292
	S.D.	557	-	6.0	0.31	3.3	2.6	12	1419	0.073	304	13	-	16	16	1	6.1	15.3	12
	C.V.(%)	3	-	6	25	35	6	3	4	25	3	4	-	25	11	8	7	16	4
	MAX.	21900	16	101.0	1.60	13.2	47.7	364	34900	0.375	10300	374	<0.8	84	162	14	88.5	115.0	303
	MIN.	20800	<8	89.6	1.04	6.6	42.5	341	32100	0.229	9730	349	<0.8	54	131	12	76.4	85.9	279

APPENDIX IVF DESCRIPTIVE STATISTICS OF SEDIMENT TRACE METAL CONCENTRATIONS - JUNE 1986 (continued)

		CONCENTRATION (ug/g dry weight)																	
STATION	STATISTIC	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	V	Zn
21B	MEAN(3)	20200	-	82.1	0.86	9.0	42.5	336	33533	0.277	9270	346	-	42	112	8	78.7	97.2	242
	S.D.	2138	-	8.3	0.01	2.6	2.3	17	1159	0.095	977	25	-	4	7	3	8.8	2.7	20
	C.V.(%)	11	-	10	1	29	5	5	3	34	11	7	-	10	6	38	11	3	8
	MAX.	21900	15	88.4	0.86	10.8	44.1	356	34300	0.382	9950	362	<0.8	47	119	11	86.3	99.7	265
	MIN.	17800	<8	72.7	0.85	6.0	39.9	324	32200	0.197	8150	317	<0.8	40	106	5	69.0	94.3	228
21C	MEAN(3)	21700	-	84.7	0.86	10.7	42.0	402	32233	0.258	9657	359	-	34	90	7	76.3	91.3	224
	S.D.	361	-	2.9	0.06	1.7	0.7	9	1102	0.046	235	4	-	3	4	1	0.7	7.0	6
	C.V.(%)	2	-	3	7	16	2	2	3	18	2	1	-	8	4	16	1	8	3
	MAX.	22000	<8	86.4	0.90	12.5	42.8	408	33500	0.309	9900	364	<0.8	36	95	8	77.1	99.2	230
	MIN.	21300	<8	81.4	0.79	9.1	41.6	392	31500	0.219	9430	356	<0.8	31	88	6	75.7	86.1	218
22A	MEAN(3)	24567	-	188	1.63	12.7	37.0	328	34467	0.450	10283	466	-	22	147	17	80.3	94.7	333
	S.D.	1270	-	20	0.35	2.4	1.3	18	1537	0.020	749	28	-	1	28	1	4.8	2.9	38
	C.V.(%)	5	-	10	22	19	3	6	4	4	7	6	-	5	19	6	6	3	11
	MAX.	25300	12	208	2.00	14.8	38.2	349	35500	0.470	10900	486	<0.8	23	179	18	84.7	96.4	373
	MIN.	23100	<8	169	1.30	10.0	35.7	315	32700	0.431	9450	434	<0.8	21	127	16	75.1	91.4	297
22B	MEAN(3)	20867	-	121	1.50	12.1	39.4	839	32067	0.314	9320	359	-	28	120	14	74.7	86.6	363
	S.D.	1097	-	14	0.26	3.1	2.1	98	1106	0.057	429	12	-	3	12	2	3.0	3.7	26
	C.V.(%)	5	-	11	18	25	5	12	3	18	5	3	-	11	10	15	4	4	7
	MAX.	22100	11	130	1.70	15.7	41.4	941	33100	0.380	9780	373	<0.8	31	130	16	76.8	89.3	392
	MIN.	20000	<8	105	1.20	10.2	37.2	746	30900	0.278	8930	349	<0.8	25	107	12	71.3	82.4	341
22C	MEAN(3)	22333	-	90.1	0.82	12.3	42.4	859	32133	0.246	10633	372	-	31	95	14	74.3	82.0	237
	S.D.	945	-	3.7	0.03	1.6	1.2	84	493	0.038	586	10	-	1	10	2	3.3	1.4	17
	C.V.(%)	4	-	4	4	13	3	10	2	15	6	3	-	3	11	11	4	2	7
	MAX.	23400	13	94.2	0.85	14.1	43.8	909	32700	0.280	11300	383	<0.8	32	105	16	78.1	83.4	256
	MIN.	21600	<8	86.9	0.80	11.0	41.4	762	31800	0.205	10200	366	<0.8	30	85	13	72.4	80.6	222

APPENDIX IVF DESCRIPTIVE STATISTICS OF SEDIMENT TRACE METAL CONCENTRATIONS - JUNE 1986 (continued)

		CONCENTRATION (ug/g dry weight)																	
STATION	STATISTIC	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	V	Zn
23	MEAN(3)	20133	-	93.9	1.23	10.8	39.7	991	29467	0.360	8813	324	-	26	88	7	79.0	82.5	276
	S.D.	306	-	0.8	0.06	4.2	1.0	51	252	0.177	25	3	-	0	7	1	2.8	1.3	15
	C.V.(%)	2	-	1	5	39	3	5	1	49	0	1	-	0	8	14	4	2	5
	MAX.	20400	<8	94.6	1.30	15.5	40.8	1040	29700	0.564	8840	327	<0.8	26	96	8	80.6	83.6	291
	MIN.	19800	<8	93.0	1.20	7.7	38.8	939	29200	0.252	8790	321	<0.8	26	82	6	75.7	81.1	261
24	MEAN(3)	22300	-	96.3	0.91	10.2	41.9	452	29800	0.280	9593	347	-	31	92	8	129	81.4	200
	S.D.	265	-	3.3	0.08	2.9	0.9	27	300	0.013	121	2	-	4	5	1	6	0.9	6
	C.V.(%)	1	-	3	8	29	2	6	1	5	1	0	-	11	5	13	5	1	3
	MAX.	22500	<8	99.9	1.00	13.4	42.7	476	30100	0.292	9720	348	<0.8	34	97	9	134	82.3	207
	MIN.	22000	<8	93.4	0.87	7.6	41.0	423	29500	0.266	9480	345	<0.8	27	87	7	122	80.6	195
25A	MEAN(3)	17700	-	93.7	1.37	8.3	51.7	343	26867	4.597	7780	274	-	27	343	20	61.1	72.7	292
	S.D.	2066	-	13.5	0.42	1.2	6.4	71	2248	4.379	1237	22	-	3	27	2	7.2	1.7	40
	C.V.(%)	12	-	14	30	14	12	21	8	95	16	8	-	11	8	9	12	2	14
	MAX.	19400	9	102.0	1.70	9.6	56.7	398	28800	9.630	8620	294	<0.8	30	367	22	68.1	73.8	326
	MIN.	15400	<8	78.1	0.90	7.4	44.4	263	24400	1.660	6360	250	<0.8	24	313	19	53.8	70.8	248
25B	MEAN(3)	13367	-	62.3	1.31	7.8	31.7	332	21833	0.674	5823	238	-	25	241	10	45.3	62.2	248
	S.D.	1021	-	4.1	0.41	0.3	3.6	55	1401	0.542	521	13	-	9	14	2	4.6	2.7	14
	C.V.(%)	8	-	7	31	3	11	17	6	81	9	6	-	37	6	16	10	4	6
	MAX.	14100	<8	65.9	1.60	8.1	35.0	396	23200	1.270	6330	249	<0.8	36	253	11	50.6	65.0	257
	MIN.	12200	<8	57.8	0.84	7.6	27.8	300	20400	0.210	5290	223	<0.8	19	225	8	42.2	59.6	232
25C	MEAN(3)	21233	-	89.4	0.89	13.4	43.2	435	30867	0.447	9697	347	-	32	135	7	73.2	79.4	237
	S.D.	808	-	4.1	0.01	3.0	0.8	23	1168	0.016	520	12	-	4	17	1	1.6	2.1	14
	C.V.(%)	4	-	5	1	22	2	5	4	3	5	3	-	12	12	8	2	3	6
	MAX.	22100	9	91.9	0.90	16.8	43.9	461	31900	0.463	10100	358	<0.8	36	147	8		81.1	250
	MIN.	20500	<8	84.7	0.88	11.4	42.4	417	29600	0.432	9110	335	<0.8	29	116	7	71.7	77.1	222

APPENDIX IVF DESCRIPTIVE STATISTICS OF SEDIMENT TRACE METAL CONCENTRATIONS - JUNE 1986 (concluded)

		CONCENTRATION (ug/g dry weight)																	
STATION	STATISTIC	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	V	Zn
26	MEAN(3)	18733	-	83.0	1.07	15.7	36.7	544	28400	0.482	8640	331	-	54	96	9	63.2	76.2	209
	S.D.	1069	-	5.0	0.55	3.7	2.9	50	1153	0.161	540	13	-	9	4	1	5.7	1.9	4
	C.V.(%)	6	-	6	51	23	8	9	4	33	6	4	-	16	4	11	9	3	2
	MAX.	19900	<8	86.3	1.70	19.9	40.0	601	29700	0.619	9260	346	<0.8	60	99	10	68.7	78.4	213
	MIN.	17800	9	77.3	0.70	13.0	34.4	506	27500	0.305	8270	322	<0.8	44	92	8	57.4	74.8	206
28	MEAN(3)	19500	22	104.4	1.37	13.6	41.7	434	30733	0.496	9003	339	-	28	181	14	67.6	77.5	374
	S.D.	700	11	9.6	0.15	2.2	0.3	8	462	0.300	151	7	-	2	11	5	2.0	2.6	30
	C.V.(%)	4	50	9	11	16	1	2	2	60	2	2	-	5	6	37	3	3	8
	MAX.	20300	32	115.0	1.50	15.6	42.0	444	31000	0.800	9110	346	<0.8	30	188	19	69.7	80.5	403
	MIN.	19000	10	96.3	1.20	11.3	41.4	429	30200	0.200	8830	333	<0.8	27	168	9	65.7	75.7	343
29	MEAN(3)	18500	-	78.2	1.01	11.7	35.5	352	28000	0.286	8507	329	-	26	83	10	62.3	76.1	211
	S.D.	1411	-	4.1	0.34	2.8	2.5	24	1253	0.024	545	16	-	1	6	3	4.6	2.3	9
	C.V.(%)	8	-	5	34	24	7	7	4	8	6	5	-	2	7	24	7	3	4
	MAX.	20000	10	81.2	1.40	14.0	37.7	366	29200	0.309	9060	345	<0.8	27	88	13	65.6	77.7	218
	MIN.	17200	<8	73.5	0.79	8.5	32.8	325	26700	0.262	7970	313	<0.8	26	77	8	57.1	73.5	200
30	MEAN(3)	17333	-	89.8	1.10	9.6	34.2	418	26100	2.221	7687	304	-	27	116	10	65.3	71.3	313
	S.D.	850	-	9.0	0.10	5.1	1.3	64	458	3.160	266	7	-	4	12	3	5.3	1.7	46
	C.V.(%)	5	-	10	9	54	4	15	2	142	3	2	-	15	10	24	8	2	15
	MAX.	18300	13	98.0	1.20	15.5	35.1	491	26600	5.870	7860	310	<0.8	32	129	13	68.5	73.0	348
	MIN.	16700	<8	80.1	1.00	6.3	32.7	378	25700	0.362	7380	296	<0.8	24	108	8	59.2	69.6	261
31	MEAN(2)	14050	-	50.9	0.36	8.0	33.4	178	30950	0.127	6145	265	-	16	47	7	97	100.9	114
	S.D	495	-	0.4	0.08	1.2	0.4	21	778	0.008	290	11	-	2	5	1	37	3.0	9
	C.V.(%)	4	-	1	24	15	1	12	3	7	5	4	-	14	11	20	38	3	8
	MAX.	14400	10	51.2	0.42	8.8	33.7	193	31500	0.133	6350	272	<0.8	17	50	8	123	103.0	120
	MIN.	13700	<8	50.6	0.30	7.1	33.1	163	30400	0.121	5940	257	<0.8	14	43	6	71	98.8	107

NOTE: A Single sample was taken from Station 27. Refer to raw data (Append IIIF) for values.

APPENDIX IVG DESCRIPTIVE STATISTICS OF SEDIMENT TRACE METAL CONCENTRATIONS - SEPTEMBER 1986

		CONCENTRATION (ug/g dry weight)																	
STATION	STATISTIC	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	V	Zn
ATK	MEAN(3)	28267	-	104.7	0.53	13.6	56.8	241	39400	0.260	14167	491	-	42	67	6	78.4	94.1	155
	S.D.	551	-	4.6	0.22	1.7	2.0	11	1153	0.025	58	13	-	1	2	1	1.3	1.9	6
	C.V.(%)	2	-	4	42	13	4	5	3	10	0	3	-	2	3	10	2	2	4
	MAX.	28900	18	110.0	0.70	15.5	59.1	253	40700	0.289	14200	506	<0.8	43	69	6	79.9	96.2	160
	MIN.	27900	<8	102.0	0.28	12.2	55.6	232	38500	0.244	14100	480	<0.8	41	65	5	77.3	92.7	148
PEI	MEAN(3)	28200	-	109.3	0.55	15.5	57.6	194	39267	0.228	13800	491	-	43	64	9	75.5	97.0	149
	S.D.	1300	-	6.8	0.25	2.6	1.8	42	503	0.026	458	22	-	2	6	1	1.4	2.1	9
	C.V.(%)	5	-	6	46	17	3	21	1	11	3	5	-	4	9	12	2	2	6
	MAX.	29700	37	117.0	0.70	17.3	59.5	220	39800	0.257	14300	516	<0.8	45	70	10	77.1	99.4	155
	MIN.	27400	<8	104.0	0.26	12.5	55.9	146	38800	0.208	13400	472	<0.8	42	59	8	74.4	95.3	139
3A	MEAN(3)	25200	-	97.9	7.43	12.2	47.9	1187	33167	0.306	10900	380	-	35	255	-	71.9	87.3	1280
	S.D.	436	-	1.0	0.25	0.8	0.5	29	321	0.030	608	5	-	1	21	-	2.1	0.5	78
	C.V.(%)	2	-	1	3	6	1	2	1	10	6	1	-	2	8	-	3	1	6
	MAX.	25700	8	99.0	7.70	12.8	48.4	1220	33400	0.336	11600	385	<0.8	35	278	<2	74.3	87.8	1370
	MIN.	24900	<8	97.3	7.20	11.3	47.4	1170	32800	0.277	10500	375	<0.8	34	238	<2	70.5	86.9	1230
3B	MEAN(3)	18367	-	74.7	6.60	10.7	47.1	1967	38800	0.179	7210	307	-	44	262	-	91.3	24.7	1260
	S.D.	814	-	4.6	0.70	2.2	0.9	418	1442	0.002	401	4	-	10	46	-	5.5	2.5	197
	C.V.(%)	4	-	6	11	21	2	21	4	1	6	1	-	22	18	-	6	2	16
	MAX.	19300	13	79.3	7.40	12.0	47.7	2270	40000	0.180	7670	312	<0.8	52	315	<2	97.5	27.0	1480
	MIN.	17800	<8	70.1	6.10	8.1	46.1	1490	37200	0.177	6930	304	<0.8	33	228	<2	86.9	22.0	1100
4B	MEAN(3)	20233	-	78.2	4.50	10.2	42.7	1420	33633	0.265	8533	335	-	39	188	-	74.3	6.7	828
	S.D.	1429	-	7.5	0.26	0.5	1.7	199	1050	0.043	1148	19	-	3	27	-	3.1	2.8	98
	C.V.(%)	7	-	10	6	5	4	14	3	16	13	6	-	7	14	-	4	3	12
	MAX.	21800	<8	85.8	4.80	10.7	44.7	1650	34700	0.307	9780	357	<0.8	41	213	4	77.0	00.0	904
	MIN.	19000	<8	70.8	4.30	9.7	41.6	1300	32600	0.222	7520	322	<0.8	36	159	<2	70.9	95.0	717

APPENDIX IVG DESCRIPTIVE STATISTICS OF SEDIMENT TRACE METAL CONCENTRATIONS - SEPTEMBER 1986 (continued)

		CONCENTRATION (ug/g dry weight)																	
STATION	STATISTIC	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	V	Zn
11B	MEAN(3)	15333	-	47.8	0.44	4.5	26.2	181	24967	0.099	6270	293	-	13	48	5	60.0	79.0	116
	S.D.	3235	-	15.1	0.11	0.5	5.7	64	3053	0.043	1546	38	-	5	17	3	10.0	3.7	40
	C.V.(%)	21	-	32	24	11	22	35	12	44	25	13	-	41	34	53	17	5	35
	MAX.	17900	<8	59.8	0.54	4.9	31.4	218	28100	0.133	7670	326	<0.8	17	62	7	68.9	82.5	146
	MIN.	11700	<8	30.9	0.33	3.9	20.1	107	22000	0.050	4610	251	<0.8	7	30	2	49.2	75.1	71
14	MEAN(3)	17200	-	62.4	0.56	5.2	32.6	333	27400	0.327	6757	327	-	22	64	3	64.7	81.8	155
	S.D.	1353	-	6.1	0.05	1.5	1.9	29	1308	0.325	604	17	-	2	5	1	3.4	1.6	11
	C.V.(%)	8	-	10	8	29	6	9	5	100	9	5	-	9	7	35	5	2	7
	MAX.	18600	<8	69.1	0.61	6.7	34.8	353	28900	0.702	7410	347	<0.8	24	68	4	68.0	63.5	168
	MIN.	15900	<8	57.2	0.52	3.7	31.4	300	26500	0.133	6220	315	<0.8	20	59	2	61.3	80.4	148
15	MEAN(3)	19733	-	70.8	0.63	8.3	41.7	352	32433	0.212	9460	377	-	31	82	5	72.0	85.1	178
	S.D.	1012	-	5.7	0.06	1.4	3.9	46	2060	0.028	545	27	-	2	4	1	4.2	0.8	10
	C.V.(%)	5	-	8	10	16	9	13	6	13	6	7	-	5	4	20	6	1	5
	MAX.	20900	<8	76.5	0.70	9.7	45.1	405	34000	0.241	10000	399	<0.8	32	86	6	76.6	85.6	186
	MIN.	19100	<8	65.1	0.58	7.0	37.4	325	30100	0.186	8910	347	<0.8	29	79	4	68.2	84.2	167
16	MEAN(3)	14000	-	45.9	0.44	4.9	25.8	191	23533	0.162	6050	272	-	15	47	-	50.9	72.3	106
	S.D.	173	-	1.4	0.12	0.4	0.7	3	551	-	139	3	-	1	4	-	1.7	3.1	10
	C.V.(%)	1	-	3	26	8	3	2	2	-	2	1	-	7	9	-	3	4	10
	MAX.	14200	<8	47.1	0.52	5.3	26.3	194	24100	0.196	6210	276	<0.8	16	51	4	52.8	75.7	115
	MIN.	13900	<8	44.3	0.31	4.5	25.0	189	23000	0.127	5960	270	<0.8	14	43	<2	49.4	69.6	95
17	MEAN(3)	20367	-	77.2	0.54	12.2	37.3	258	28533	0.315	8890	352	-	26	76	7	70.4	78.6	147
	S.D.	1258	-	5.2	0.11	2.8	3.0	24	1845	0.064	628	20	-	4	9	2	2.5	3.5	12
	C.V.(%)	6	-	7	20	23	8	9	6	20	7	6	-	14	11	28	4	4	8
	MAX.	21700	<8	83.0	0.60	13.9	40.3	274	30100	0.384	9480	370	<0.8	29	84	9	73.3	81.9	156
	MIN.	19200	<8	72.9	0.41	9.0	34.3	231	26500	0.257	8230	330	<0.8	22	67	5	68.8	75.0	134

APPENDIX IVG DESCRIPTIVE STATISTICS OF SEDIMENT TRACE METAL CONCENTRATIONS - SEPTEMBER 1986 (concluded)

		CONCENTRATION (ug/g dry weight)																
STATION	STATISTIC	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	V	Zn
19	MEAN(3)	21033	-	76.0	0.63	12.6	39.0	283	31000	0.236	9313	362	-	27	81	9	73.1	82.1	153
	S.D.	451	-	2.7	0.21	1.4	1.6	11	346	0.009	273	10	-	3	3	2	1.4	1.3	7
	C.V.(%)	2	-	4	34	11	4	4	1	4	3	3	-	12	3	24	2	2	5
	MAX.	21500	<8	78.8	0.80	14.2	40.8	291	31200	0.245	9500	371	<0.8	31	84	11	74.7	83.4	159
	MIN.	20600	<8	73.4	0.39	11.4	37.9	271	30600	0.228	9000	352	<0.8	25	79	7	71.9	80.9	145
35	MEAN(3)	29233	15	99.1	0.87	9.6	73.7	172	37233	0.404	12067	412	-	31	118	6	87.4	93.1	188
	S.D.	814	3	2.5	0.12	1.2	1.6	9	907	0.008	321	9	-	0	2	1	2.1	1.3	6
	C.V.(%)	3	17	2	13	13	2	5	2	2	3	2	-	0	2	10	2	1	3
	MAX.	29800	17	101.0	1.00	10.7	75.5	178	37900	0.413	12300	421	<0.8	31	120	6	89.4	94.1	192
	MIN.	28300	12	96.3	0.80	8.3	72.8	161	36200	0.397	11700	403	<0.8	31	116	5	85.2	91.6	182
38	MEAN(3)	28733	20	96.1	1.03	10.0	80.9	157	38267	0.407	12067	400	-	32	132	8	86.0	93.1	223
	S.D.	666	10	3.4	0.12	0.8	2.9	3	569	-	208	3	-	1	7	0	1.9	1.2	18
	C.V.(%)	2	49	4	11	8	4	2	1	-	2	1	-	3	6	0	2	1	8
	MAX.	29500	27	100.0	1.10	10.9	84.0	160	38900	0.412	12300	402	<0.8	33	140	8	88.0	94.3	243
	MIN.	28300	9	93.7	0.90	9.3	78.2	155	37800	0.402	11900	397	<0.8	31	126	8	84.3	92.0	211

APPENDIX B

VANCOUVER HARBOUR BENTHIC ENVIRONMENTAL QUALITY STUDIES
MAY 1985 - SEPTEMBER 1986

ORGANIC COMPOUNDS IN SEDIMENT

By

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D. GOYETTE

OCTOBER 1989

REVIEW NOTICE

Data reports are prepared to make data available without full analysis or interpretation. This report has been reviewed by the Marine Programs Division, Environmental Protection, and approved for limited distribution. For further information please contact:

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TABLE OF CONTENTS

PAGE

REVIEW NOTICE i

TABLE OF CONTENTS ii

List of Tables iii

List of Figures iv

1.0 INTRODUCTION 1

2.0 MATERIAL AND METHODS 2

2.1 Study Area 2

2.2 Field Collection 5

2.3 Laboratory Analysis 5

2.3.1 Oils and Grease 5

2.3.2 Hydrocarbons 8

2.3.3 Polycyclic Aromatic Hydrocarbons (PAH) 8

2.3.4 Polychlorinated Biphenyls (PCB) 10

2.3.5 Chlorophenols 11

3.0 RESULTS AND DISCUSSION 12

REFERENCES 28

ACKNOWLEDGEMENTS 29

APPENDIX I Vancouver Harbour Sampling Station Coordinates and Depths (1985-86) 30

APPENDIX II Sediment Organics - Raw Data - Oils and Grease, Hydrocarbon, Polychlorinated Biphenyls and Chlorophenol Concentrations - Vancouver Harbour (1985-1986) 34

APPENDIX III Sediment Polycyclic Aromatic Hydrocarbon Concentrations - Results from Interlaboratory Blind Split Samples 40

TABLE OF CONTENTS (CONTINUED)

PAGE

APPENDIX IV Sediment Polycyclic Aromatic Hydrocarbons - Results from Internal Laboratory Duplicates by Laboratory B in µg/g Dry Weight 42

APPENDIX V Sediment Polycyclic Aromatic Hydrocarbon (PAH) Concentrations in µg/g Dry Weight - Vancouver Harbour 1985 - 1986 45

LIST OF TABLES

PAGE

Table 1 Vancouver Harbour Sediment Sampling Schedule for Surveys Conducted in 1985-86 6

Table 2 Mean Concentrations of Oils and Grease, Hydrocarbons, Polychlorinated Biphenyls and Chlorophenols in Vancouver Harbour (1985-86) 13

Table 3 Comparison of Sediment Oils and Grease, Hydrocarbon, Polychlorinated Biphenyl and Chlorphenol Concentrations Between Field Surveys in Vancouver Harbour (1985-86) .. 23

Table 4 Sediment Polycyclic Aromatic Hydrocarbon Concentrations (µg/g Dry Weight) in Vancouver Harbour (1985-86) 25

LIST OF FIGURES

PAGE

Figure 1 Sediment Organic Sampling Stations in Vancouver Harbour (1985-86)
(a) Outer and Inner Harbour 3
(b) Port Moody Arm 4

Figure 2 Mean Surface Sediment Oils and Grease Concentration in µg/g Dry Weight (1985-86)
(a) Outer and Inner Harbour 15
(b) Port Moody Arm 16

Figure 3 Mean Surface Sediment Hydrocarbon in µg/g Dry Weight (1985-86)
(a) Outer and Inner Harbour 17
(b) Port Moody Arm 18

Figure 4 Mean Surface Sediment Polychlorinated Biphenyl (PCB) Concentration in µg/g Dry Weight (1985-86)
(a) Outer and Inner Harbour 19
(b) Port Moody Arm 20

Figure 5 Mean Surface Sediment Pentachorophenol (PCP) Concentration in µg/g Dry weight (1985-86)
(a) Outer and Inner Harbour 21
(b) Port Moody Arm 22

Figure 6 Total Sediment Polycyclic Aromatic Hydrocarbon (PAH) Concentration (µg/g Dry Weight) - Vancouver Harbour (1985-86) 27

1.0 INTRODUCTION

Environment Canada initiated a series of benthic environmental quality surveys in Vancouver Harbour in May 1985. Emphasis was placed on sampling surficial bottom sediments for geographic distribution patterns of selected trace metals and organic compounds in Vancouver Harbour. The trace metals in sediment data has been documented in Thomas and Goyette (1989a). Sediment particle size distribution, residue and bacteria content data are presented in Thomas and Goyette (1989e). Epibenthic invertebrates and bottomfish were collected for tissue trace metal analysis (Thomas and Goyette, 1989b). Distribution and abundance of benthic species (Thomas and Goyette, 1987), polycyclic aromatic hydrocarbon concentrations in flatfish and Dungeness crab tissue (Thomas and Goyette, 1989d), and the prevalence of liver lesions and external abnormalities in flatfish (Goyette et al., 1988), have been reported.

Organic compounds represent an important component in environmental studies associated with urban centres. Sources of such compounds include oil refinery wastes, road and general urban runoff, lumber treatment facilities, marine traffic, atmospheric fallout, municipal effluents, among others. The purpose of the current report is to document organic compound concentration (oils and grease, hydrocarbons, various polycyclic aromatic hydrocarbons (PAH), polychlorinated biphenyls (PCB) and chlorophenols (tri, penta, and tetra)) in surface sediment collected from Vancouver Harbour between May 1985 and September 1986.

2.0 MATERIALS AND METHODS

2.1 Study Area

Vancouver Harbour (Point Atkinson to Port Moody Arm) was subdivided into four hydrographic regions for study; stations are indicated in brackets:

OUTER HARBOUR - Spanish Banks (SB)
- Point Atkinson (ATK)
- Pacific Environment Institute (PEI)
- Dundarave (DD)

INNER HARBOUR - North Shore (1 to 13B)
- Centre (14 to 16)
- South Shore (17 to 31)

CENTRAL HARBOUR - Cates Park (CP)
- Boulder Rock (BR)

EASTERN HARBOUR - Port Moody Arm (32 to 47)

In total, 73 stations were established for study between May 1985 and September 1986 (Figure 1a and 1b). Out of the 73 stations, 59 were sampled for oils and grease, hydrocarbons, polychlorinated biphenyls (PCB), and chlorophenols (penta, tetra, tri), and 23 for polycyclic aromatic hydrocarbons (PAH). Sampling stations consisted of sites immediately adjacent to discharges or shorebased activities and stations further from shore to examine the extent of contamination. Seven stations corresponded to otter trawl sampling stations (mid-point along transect), used for tissue collections (Thomas and Goyette 1989b, 1989d). The trawl sites were sampled from 3 to 5 times during the study to determine the stability of organic chemical concentrations in sediment during the survey period. The remaining stations were sampled only once.

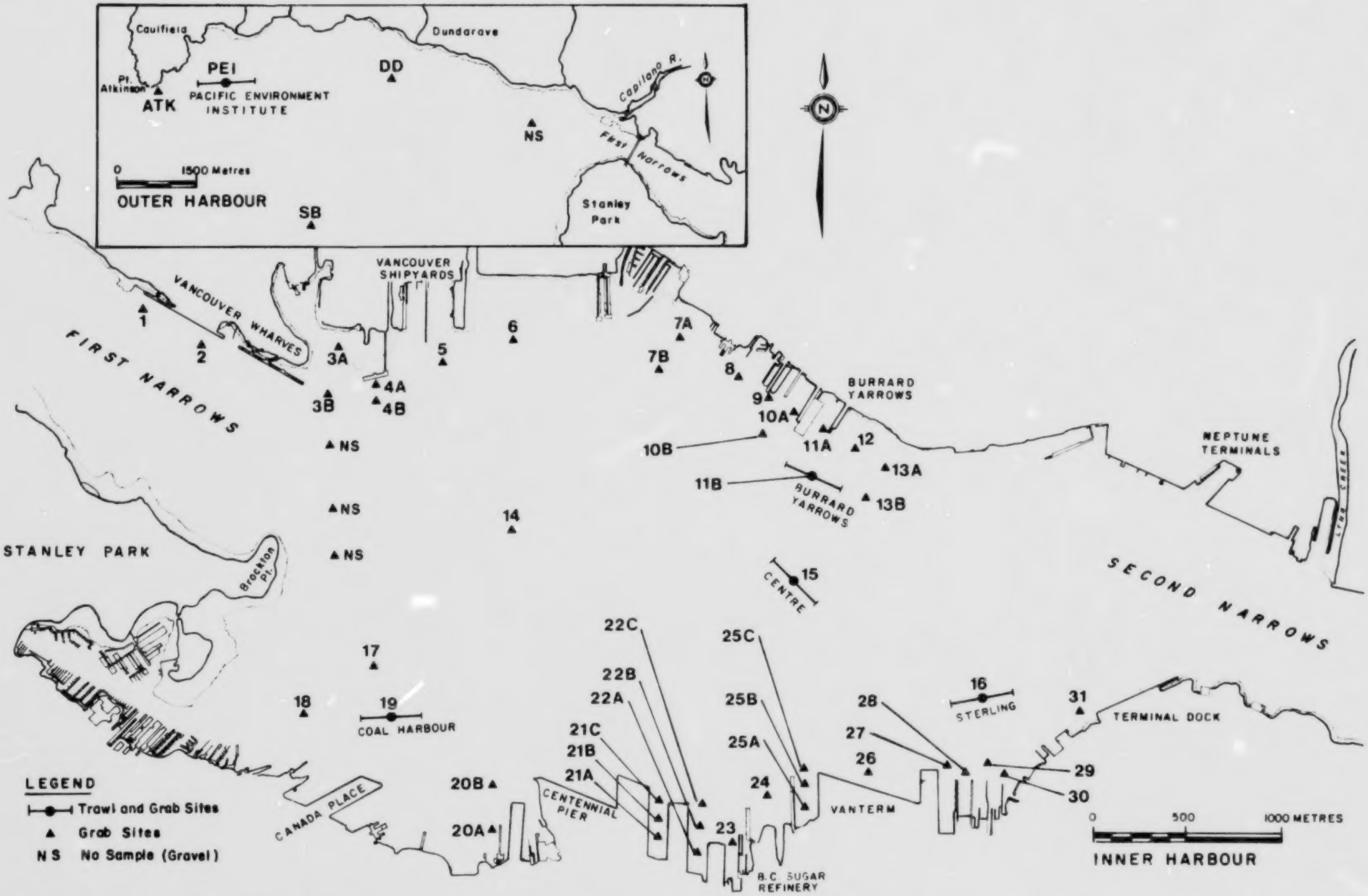
Caulfield
Pt. Atkinson
ATK
PEI
PACIFIC ENVIRONMENT INSTITUTE
DD
Dundarave
NS
Capilano R.
First Narrows
Stanley Park
0
1500 Metres
OUTER HARBOUR
SB
N
VANCOUVER WHARVES
1
2
FIRST NARROWS
3A
3B
4A
4B
VANCOUVER SHIPYARDS
5
6
7A
7B
8
9
10A
10B
BURRARD YARROWS
11A
12
13A
11B
BURRARD YARROWS
13B
NEPTUNE TERMINALS
LYNN CREEK
NS
NS
NS
14
STANLEY PARK
Brockton Pt.
15
CENTRE
SECOND NARROWS
17
18
19
COAL HARBOUR
22C
22B
22A
21C
21B
21A
25C
25B
25A
24
23
28
27
26
16
STERLING
31
TERMINAL DOCK
29
30
20B
20A
CANADA PLACE
CENTENNIAL PIER
B.C. SUGAR REFINERY
VANTERM
0
500
1000 METRES
INNER HARBOUR
LEGEND
Trawl and Grab Sites
▲ Grab Sites
NS No Sample (Gravel)

FIGURE 1a Sediment Organic Sampling Stations in Vancouver Harbour (1985-86) - Outer and Inner Harbour

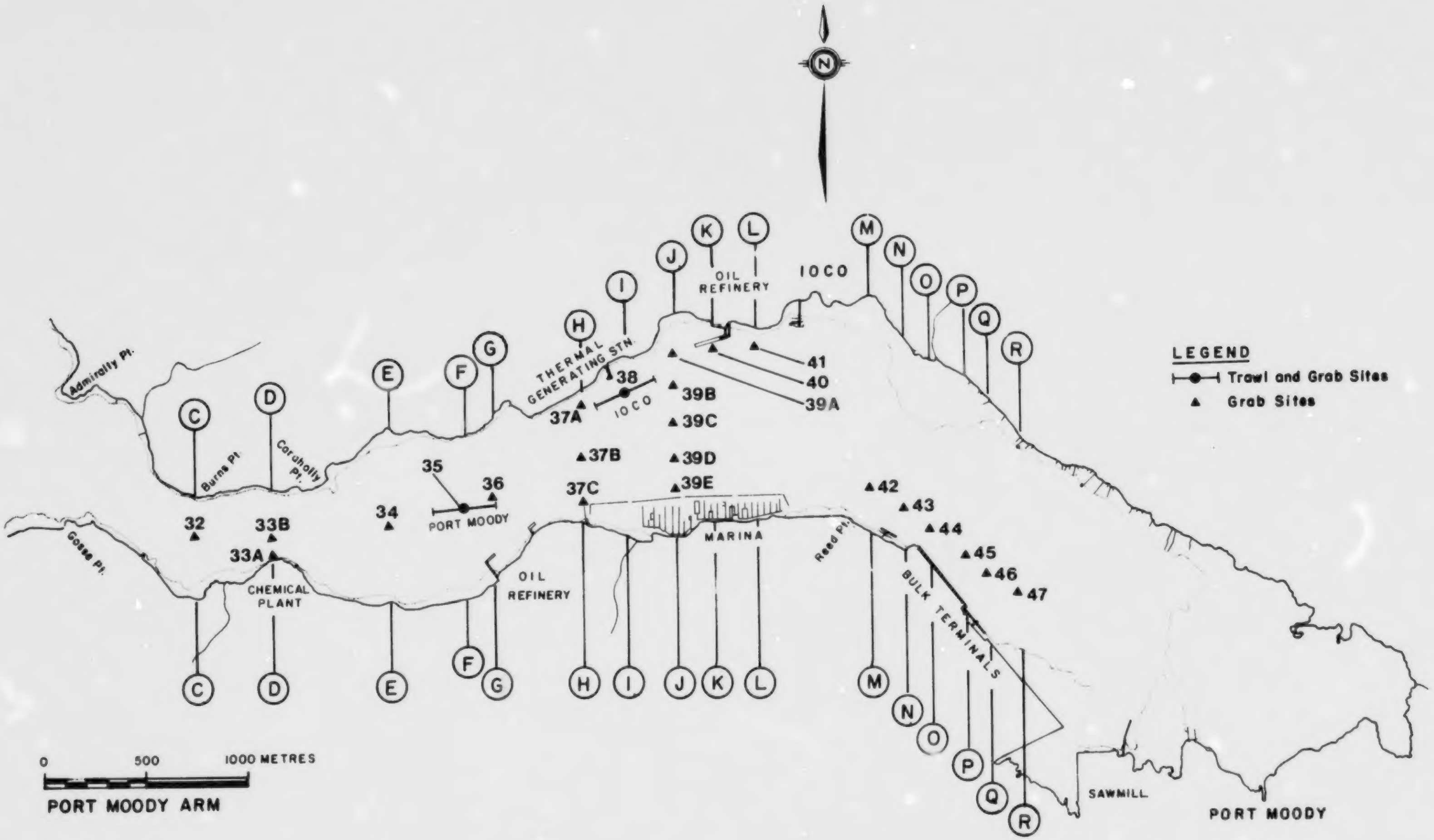
N
LEGEND
Trawl and Grab Sites
Grab Sites
Admiralty Pt.
Burns Pt.
Caraholly Pt.
Gosse Pt.
Reed Pt.
THERMAL GENERATING STN.
IOCO
OIL REFINERY
IOCO
PORT MOODY
CHEMICAL PLANT
OIL REFINERY
MARINA
BULK TERMINALS
SAWMILL
PORT MOODY
C
D
E
F
G
H
I
J
K
L
M
N
O
P
Q
R
32
33A
33B
34
35
36
37A
37B
37C
38
39A
39B
39C
39D
39E
40
41
42
43
44
45
46
47
0
500
1000 METRES
PORT MOODY ARM

FIGURE 1b Sediment Organic Sampling Stations in Vancouver Harbour (1985-86) - Port Moody Arm

2.2 Field Collection

Seven surveys were conducted from the research vessel CSS Vector. The sampling schedule is provided in Table 1. Station coordinates and depths are provided in Appendix I.

Sediment surface grabs were obtained using a 0.1 square metre stainless steel Smith-MacIntyre grab. Subsamples were taken from the top two centimeters and placed into heat-treated glass jars with aluminum foil lining the lid. Samples were kept frozen until analyzed. Additional sediment samples were taken for trace metal, particle size and residue analysis; results have been reported in other data reports (Thomas and Goyette, 1989a, 1989e). Samples, normally taken in triplicate at each site, were analyzed for oils and grease, hydrocarbons, PCB and chlorophenols by the Environmental Protection laboratory in West Vancouver. PAH samples were submitted to two external laboratories (LABORATORY A and LABORATORY B) for gas chromatograph/ mass spectroscopy (GC/MS) analysis. To maximize coverage of the harbour with the available funds, sampling was confined to 23 stations with 1 to 3 samples per site. Earlier samples submitted to two other laboratories were discarded due to problems with detection limits.

2.3 Laboratory Analysis

For a detailed description of the methodology of oils and grease, hydrocarbons, PCB and chlorophenols, refer to analytical procedure documentation available from the Environmental Protection laboratory. Procedures are summarized as follows.

2.3.1 Oils and Grease

The sample was air-dried overnight then a weighed portion placed in a centrifuge bottle with anhydrous Na_2SO_4, concentrated sulfuric acid and Freon 113. The bottle was then sealed and mixed on a wrist-action

TABLE 1 VANCOUVER HARBOUR SEDIMENT SAMPLING FOR SURVEYS CONDUCTED IN 1985-86 - ORGANIC COMPOUNDS IN SEDIMENT

AREA	STN	TOTAL NUMBER SURVEYS	MAY 1985	OCT 1985	NOV 1985	JAN 1986	MAY 1986	JUNE 1986	SEPT 1986
OUTER HARBOUR									
	SB								
	ATK	1							x
	PEI*	5	x	x		x	x		x
	DD								
INNER HARBOUR									
North Shore	1	1						x	
	2	1						x	
	3A	1							x
	3B	1							x
	4A	1			x				
	4B	1							x
	5	1			x				
	6	1			x				
	7A	1			x				
	7B	1			x				
	8	1			x				
	9	1			x				
	10A	1			x				
	10B	1			x				
	11A	1			x				
	11B*	5	x	x		x	x		x
	12	1			x				
	13A	1			x				
	13B	1			x				
Centre	14	1							x
	15	3				x	x		x
	16*	4	x	x			x		x
South Shore	17	1							
	18	1				x			
	19*	5	x	x		x	x		x
	20A	1						x	
	20B	1						x	
	21A	1						x	
	21B	1						x	
	21C	1						x	
	22A	1						x	
	22B	1						x	
	22C	1						x	

* corresponding otter travl sites

TABLE 1 (CONT'D) VANCOUVER HARBOUR SEDIMENT SAMPLING FOR SURVEYS CONDUCTED IN 1985-86 - ORGANIC COMPOUNDS IN SEDIMENT

AREA	STN	TOTAL NUMBER SURVEYS	MAY 1985	OCT 1985	NOV 1985	JAN 1986	MAY 1986	JUNE 1986	SEPT 1986
	23	1						x	
	24	1						x	
	25A	1						x	
	25B	1						x	
	25C	1						x	
	26	1						x	
	27	1						x	
	28	1						x	
	29	1						x	
	30	1						x	
	31	1						x	
CENTRAL HARBOUR	CP								
	BR								
EASTERN HARBOUR									
PT.MOODY ARM	32								
	33A								
	33B								
	34								
	35*	5	x	x		x	x		x
	36	1			x				
	37A	1			x				
	37B	1			x				
	37C	1			x				
	38	3				x	x		x
	39A	1			x				
	39B	1			x				
	39C	1			x				
	39D	1			x				
	39E	1			x				
	40	1			x				
	41	1			x				
	42								
	43								
	44								
	45								
	46								
	47								

* corresponding otter trawl sites

shaker for 90 minutes followed by centrifuging for 10 minutes. Oils and grease were quantified on an infrared spectrophotometer (5cm UV cell) as the difference in the absorbance of the freon extract measured at 4000 (baseline) and 2935 cm-1. The amount of oils and grease are reported in µg/g dry weight "standard oil" equivalent. Recovery of a "standard oil" (15ml hexadecane, 15ml iso-octane and 10ml chlorobenzene) spike at the 0.25 mg/l level gave 92% recovery with a mean of 0.23mg/l (S.D.=0.04) over 8 replicates.

2.3.2 Hydrocarbons

For hydrocarbon analysis, three grams of silica gel were added to the centrifuge freon extract portion from the oils and grease quantification, shaken for 30 minutes, centrifuged for 10 minutes, then filtered through a small funnel with GF/C paper with a small amount of Na_2SO_4 added. Hydrocarbon was quantified as per oils and grease. Total hydrocarbon concentrations are reported in µg/g dry weight "standard oil" equivalent. The precision and accuracy of this technique is the same as that reported for oils and grease infrared determination.

2.3.3 Polycyclic Aromatic Hydrocarbons (PAH)

Sediment samples were collected from 23 stations in Vancouver Harbour and submitted (March, 1987) to two external laboratories (LABORATORY A and LABORATORY B) for GC/MS analysis of individual PAH concentrations. Four stations were analyzed by LABORATORY A and 19 stations by LABORATORY B. External quality control was maintained by sending blind split samples to each laboratory for comparison by the authors (Appendix III). Field replicates from selected stations also provided a measure of analytical precision and accuracy. Summaries of the lab methodologies used are as follows:

LABORATORY A

Sediment samples were mixed well and foreign objects such as sticks, leaves, and rocks discarded. Approximately 10 g of each sediment was mixed with anhydrous sodium sulphate then soxhlet extracted for 16 hr with a dichloromethane:acetone (95:5) solution. The results were later corrected for moisture content determined on a separate sediment fraction. The dichloromethane:acetone soxhlet solution was extracted with 0.2N sodium hydroxide (pH 12) to remove acidic compounds, concentrated to small volume using a Kuderna-Danish (K-D) apparatus and made up to volume by adding dichloromethane. The sample was analyzed on a GC/MS system using multiple ion detection (MID) mode (three selected ions) for confirmation and quantification. Although reagent blanks were run routinely during analyses to monitor interferences, internal duplicates did not appear as part of the quality control procedure.

LABORATORY B

Sediment samples were dried at room temperature and passed through a #10 (2mm) seive. Approximately 15 g of sample was transferred to an extraction thimble, spiked with 3 PAH surrogate compounds (napthalene-d_8, acenaphthene-d_{10}, and 2-flurobiphenyl) to monitor extraction/recovery efficiency and then soxhlet extracted with dichloromethane for 16 hr. The dichloromethane extract was rotary evaporated to near dryness and ultimately transferred to a partially deactivated neutral alumina column topped with anhydrous sodium sulphate. Three fractions were collected by eluting the column with pentane (Fraction 1), benzene (Fraction 2) and dichloromethane (Fraction 3). Fraction 2, the PAH fraction, was evaporated to near dryness, redissolved in hexane and treated with mercury for sulphur removal. Anthracene-d_{10} was added as an internal standard and the sample analyzed on a GC/MS system using MID mode (three selected ions) for confirmation and quantification. In addition to spiking samples with surrogates, method blanks and duplicate sediments (Appendix IV) were analyzed as part of the quality control procedures.

Detection limits (μg/g, dry weight) and percent recovery for the various PAH compounds were reported by each laboratory as follows:

COMPOUND	LABORATORY A Detection Limit	LABORATORY A Percent Recovery	LABORATORY B* Detection Limit	LABORATORY B* Percent Recovery
LOW MOLECULAR WEIGHT PAH				
Napthalene	0.08	95	0.01	-
Acenaphthylene	0.18	90	0.01	77
Acenapthene	0.10		0.01	-
Anthracene/Phenanthrene	0.10/0.21	66	0.10	-
Fluorene	0.10	77	0.01	-
HIGH MOLECULAR WEIGHT PAH				
Fluoranthene	0.10	62	0.01	110
Pyrene	0.10	74	0.01	-
Chrysene/ Benzo(a)anthracene	0.13/0.10	74/75	0.01	-
Benzo(b)fluoranthene/ Benzo(k)fluoranthene	0.24/0.13	64	0.01	-
Benzo(a)pyrene	0.13	48	0.01	-
Benzo(ghi)perylene	0.21	64	0.01	-
Dibenzo(ah)anthracene	0.13	77	0.01	-
Indeno (1,2,3-cd)pyrene	0.19	62	0.01	-

* Laboratory B reported Anthracene and Phenanthrene as one value since these two compounds were isomers and eluted from the spectra as one peak. Chrysene and Benzo(a)anthracene as well as Benzo(b)fluoranthene and Benzo(k)fluoranthene were also reported as one value due to a similar phenomenon.

2.3.4 Polychlorinated Biphenyls (PCB)

The sample was air-dried, weighed and transferred to a centrifuge tube containing acetone. After agitation for two hours, the sample was filtered and the solute transferred to a separatory funnel, 2% NaCl added, and extracted with hexane. The extract was then concentrated to about 5ml on a rotary evaporator and quantitatively transferred to a 2% florisil column where it was eluted and concentrated. It was then treated successively with activated copper, sulphuric acid and mercury to remove interferences. A known amount of the concentrated sample was injected into a packed gas chromatograph with electron-capture detector.

Qualification is based on the recognition of the peak distribution pattern of the aroclors present and a comparison of retention times. Quantitative analysis is based on the injection of the appropriate standard and summation of the area of the most significant resolved GC peaks. Recovery studies with sediment samples spiked with 0.1-5.0 µg of Aroclor 1254 gave an average recovery of 89%. Coefficients of variation ranged from 1.4% to 12.7%.

2.3.5 Chlorophenols

The procedure to analyze chlorophenols (chlorinated phenols) is the same as that described for PCB except for an added step converting the phenols to anisole derivatives using diazomethane. An appropriate standard is used in the gas chromatograph. The minimum detectable concentration of pentachlorophenol and tetrachlorophenol are 0.0001 µg/g and 0.0002 µg/g, respectively. The results were obtained using a packed column gas chromatograph with electroncapture detector.

3.0 RESULTS AND DISCUSSION

Mean concentrations of oils and grease, hydrocarbon, PCB and chlorophenols are summarized in Table 2; raw data are provided in Appendix II. All concentrations are given in µg/g dry weight. Hydrocarbon analysis, unfortunately, was not done on the September 1986 samples. To provide the missing data, the mean ratio of hydrocarbon to oils and grease was calculated from the previous surveys (n=169) and applied to the oils and grease raw data from the September 1986 survey. Derived hydrocarbon value was equal to .81 oils and grease value (refer to Appendix II for specific values).

The geographical distribution for each compound in Vancouver Harbour is illustrated in Figures 2 to 5. Mean concentrations in the surface sediments for hydrocarbon ranged from 19 µg/g to 6587 µg/g; oils and grease, 39 µg/g to 9030 µg/g; PCB, <.02 µg/g to 0.903 µg/g; and pentachlorophenol (PCP), <.001 µg/g to .135 µg/g (Table 2). Loughborough Inlet, an undisturbed area due north of Campbell River along the mainland coast, was sampled in July 1987 as a reference site. Mean concentrations in sediment for hydrocarbons, oils and grease, PCB and PCP (n=3) were 66, 66, 0.04 and <0.0001 µg/g respectively (EP, unpublished data).

Statistical comparisons were made using the sampling data from the trawl sites to compare differences in concentrations between field surveys. Analysis of variance (ANOVA, P=.05) followed by the multiple comparison statistical test, Tukeys (alpha=.05) to determine where the differences lie. Differences are indicated in Table 3 by the use of alphabetical letters, such that mean values with the same letter do not differ significantly. In the case where mean values are represented by "a,b,c and ab", "a" and "b" are significantly different but cannot be distinguished from mean value "ab". However, values labelled "a, b and ab" are significantly lower than mean concentration "c". Concentrations of the specific organic compounds analysed varied considerably between sampling periods with no definite trend.

TABLE 2 MEAN CONCENTRATIONS OF OILS AND GREASE (O&G), HYDROCARBONS (HC), POLYCHLORINATED BIPHENYLS (PCB) AND CHLOROPHENOLS - VANCOUVER HARBOUR (1985 - 1986).

	CONCENTRATION (μg/g Dry Weight)							CONCENTRATION (μg/g Dry Weight)					
				CHLOROPHENOLS							CHLOROPHENOLS		
STN	O&G	HC	PCB	PENTA	TETRA	TRI	STN	O&G	HC	PCB	PENTA	TETRA	TRI
ATK	227	184*	.120	.011	.006	<.003	14	277	225*	.034	.005	.002	<.003
PEI	150	133*	.043	.004	.006	<.0003	15	309	280*	.046	.026	.003	<.0003
1	477	459	.043	.004	.015	<.0003	16	177	154*	.183	.004	.007	<.0003
2	694	670	.013	.001	.006	<.0003	17	243	198*	.091	.006	.010	<.003
3A	1150	934*	.070	.010	.020	<.003	18	534	525	.044	.061	.079	<.0003
3B	122	100*	.041	.004	.009	<.003	19	290	258*	.045	.005	.004	<.0003
4A	266	216*	.235	.011	.015	<.003	20A	413	398	.07	.002	.009	<.0003
4B	228	152	<.020	.014	.007	<.001	20B	705	687	.08	.002	.018	<.0003
5	400	237	<.020	.003	.003	<.001	21A	1100	654	.316	.001	.010	<.0003
6	381	293	.020	.003	.003	<.001	21B	724	614	.055	.003	.004	.0023
7A	344	200	.310	.007	.007	<.001	21C	761	632	.073	.003	.004	.0029
7B	329	244	.047	.003	.003	<.001	22A	2193	1883	.552	.009	.018	<.0003
8	306	163	.617	.009	.008	<.001	22B	1613	1241	.288	.001	.009	<.0003
9	303	183	.903	.010	.008	<.001	22C	1037	718	.087	.002	.031	<.0003
10A	252	160	.683	.010	.006	<.001	23	987	838	.167	.003	.007	.0013
10B	284	186	<.020	.004	.003	<.001	24	618	509	.083	.003	.005	.0020
11A	189	84	.077	.004	.002	<.001	25A	9030	6587	.517	.135	.063	.0245
11B	229	202*	.059	.005	.004	<.0003	25B	1957	1713	.439	.022	.017	.0045
12	48	27	.290	.001	.001	<.001	25C	1077	997	.151	.004	.011	.0044
13A	39	19	.020	.001	.001	<.001	26	922	916	.046	.015	.027	.0092
13B	79	40	.040	.001	.001	<.001							

TABLE 2 (CONT,D) MEAN CONCENTRATIONS OF OILS AND GREASE (O&G), HYDROCARBONS (HC), POLYCHLORINATED BIPHENYLS (PCB) AND CHLOROPHENOLS - VANCOUVER HARBOUR (1985 - 1986)

	CONCENTRATION (μg/g Dry Weight)							CONCENTRATION (μg/g Dry Weight)					
				CHLOROPHENOLS							CHLOROPHENOLS		
STN	O&G	HC	PCB	PENTA	TETRA	TRI	STN	O&G	HC	PCB	PENTA	TETRA	TRI
27	632	632	.159	.036	.033	.0132	37C	449	347	.117	.017	.012	<.001
28	2333	2310	.185	.014	.024	.0134	38	993	863*	.11	.030	.033	<.0003
29	650	622	.088	.001	.016	.0088	39A	1617	1437	.050	.014	.010	<.001
30	1207	1160	.138	.003	.008	.0029	39B	1039	890	.050	.014	.008	<.001
31	451	364	.05	.001	.001	.0009	39C	414	338	.030	.010	.007	<.001
35	843	749*	.094	.005	.008	<.0003	39D	429	363	.043	.010	.009	<.001
36	891	729	.040	.011	.009	<.001	39E	506	404	.033	.047	.013	<.001
37A	1217	1040	.040	.014	.012	<.001	40	1034	904	<.020	.007	.004	<.001
37B	726	601	.045	.012	.011	<.001	41	2090	1897	.090	.017	.015	<.001

* Mean calculated using derived values for missing hydrocarbon data in September 1986. A factor of .81 was applied to raw oils and greatest data for that survey. Refer to Appendix II for more detail.

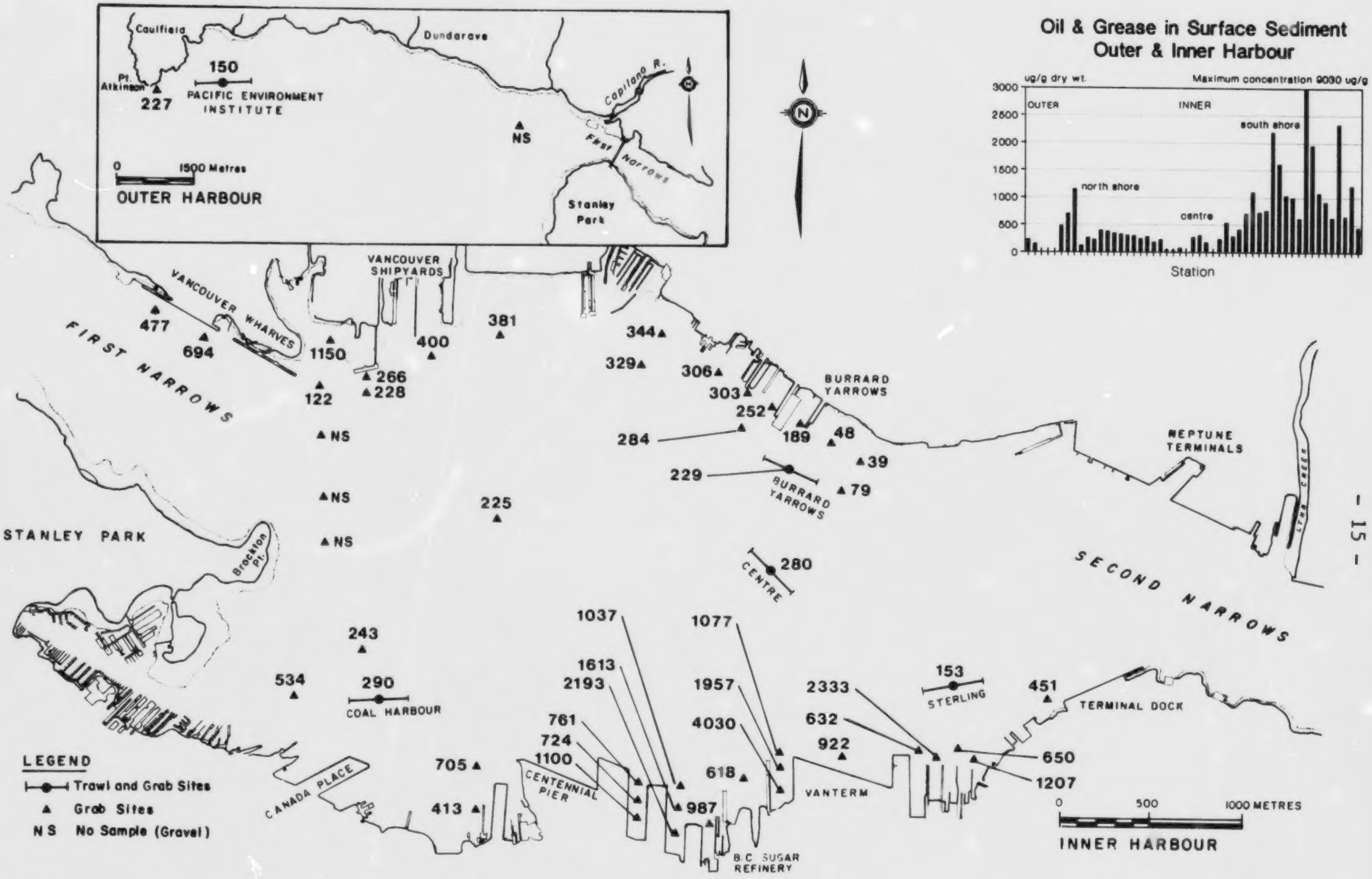
Caulfield
Pt. Atkinson
227
150
PACIFIC ENVIRONMENT INSTITUTE
Dundarave
Capilano R.
First Narrows
Stanley Park
NS
0
1500 Metres
OUTER HARBOUR
Oil & Grease in Surface Sediment
Outer & Inner Harbour
ug/g dry wt.
Maximum concentration 4030 ug/g
3000
2500
2000
1500
1000
500
0
OUTER
INNER
north shore
centre
south shore
Station
VANCOUVER WHARVES
477
694
FIRST NARROWS
1150
122
VANCOUVER SHIPYARDS
266
228
400
381
NS
NS
NS
225
344
329
306
303
252
284
189
48
39
79
229
BURRARD YARROWS
BURRARD YARROWS
NEPTUNE TERMINALS
LYNN CREEK
SECOND NARROWS
280
CENTRE
STANLEY PARK
Brockton Pt.
243
534
290
COAL HARBOUR
CANADA PLACE
705
413
CENTENNIAL PIER
1037
1613
2193
761
724
1100
987
B.C. SUGAR REFINERY
1077
1957
4030
618
VANTERM
2333
632
922
153
STERLING
451
TERMINAL DOCK
650
1207
0
500
1000 METRES
INNER HARBOUR
LEGEND
Trawl and Grab Sites
Grab Sites
NS No Sample (Gravel)

FIGURE 2a Mean Surface Sediment Oils and Grease Concentrations in µg/g Dry Weight – Outer and Inner Harbour

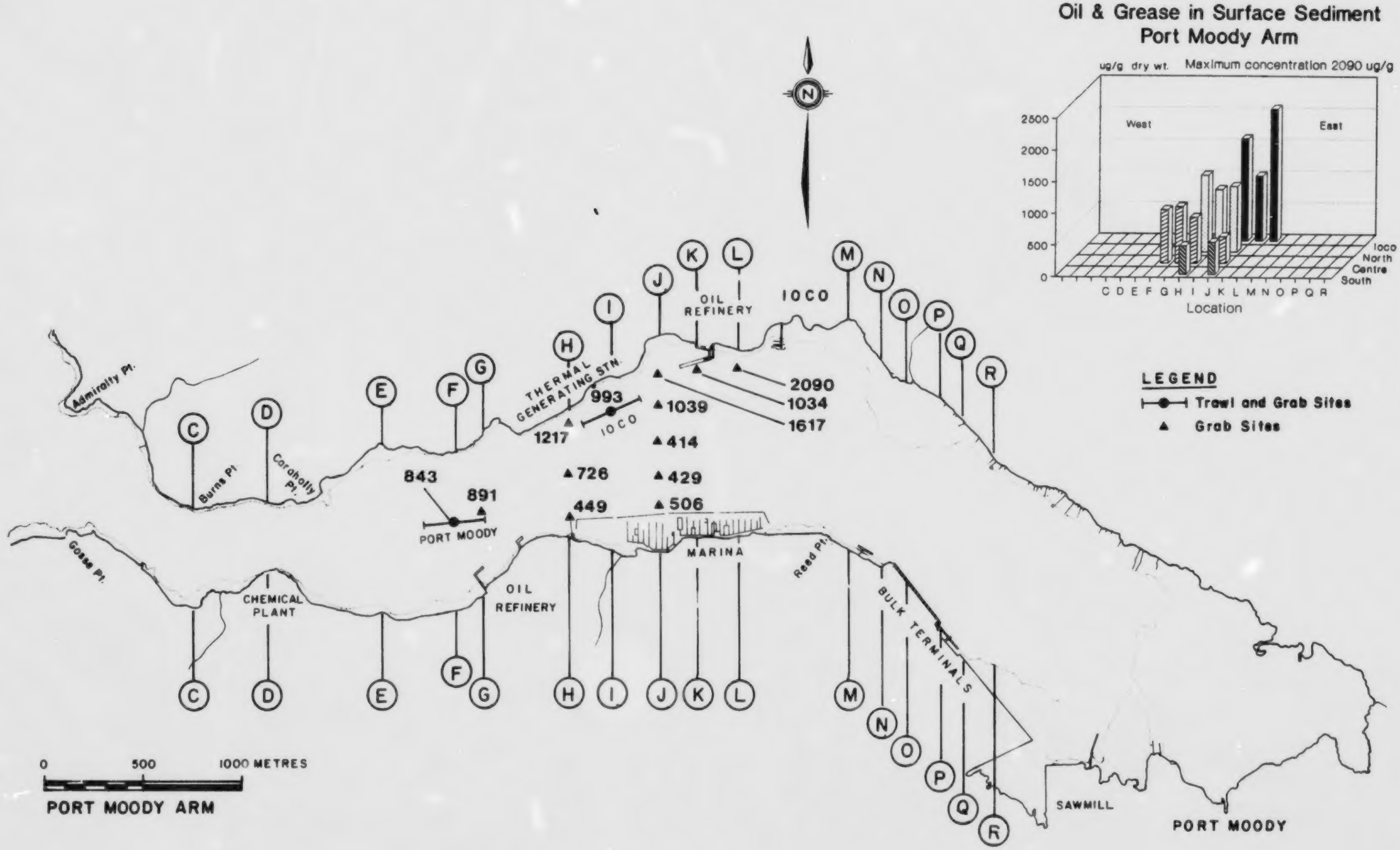
Oil & Grease in Surface Sediment
Port Moody Arm
ug/g dry wt. Maximum concentration 2090 ug/g
2500
2000
1500
1000
500
0
West
East
C D E F G H I J K L M N O P Q R
Location
Ioco
North
Centre
South
LEGEND
Trawl and Grab Sites
Grab Sites
N
Admiralty Pt.
Burns Pt.
Caraholly Pt.
Gosse Pt.
CHEMICAL PLANT
OIL REFINERY
THERMAL GENERATING STN.
IOCO
OIL REFINERY
MARINA
Reed Pt.
BULK TERMINALS
SAWMILL
PORT MOODY
C
D
E
F
G
H
I
J
K
L
M
N
O
P
Q
R
843
891
PORT MOODY
1217
993
IOCO
726
449
1039
414
429
506
2090
1034
1617
0
500
1000 METRES
PORT MOODY ARM

FIGURE 2b Mean Surface Sediment Oils and Grease Concentrations in µg/g Dry Weight – Port Moody Arm

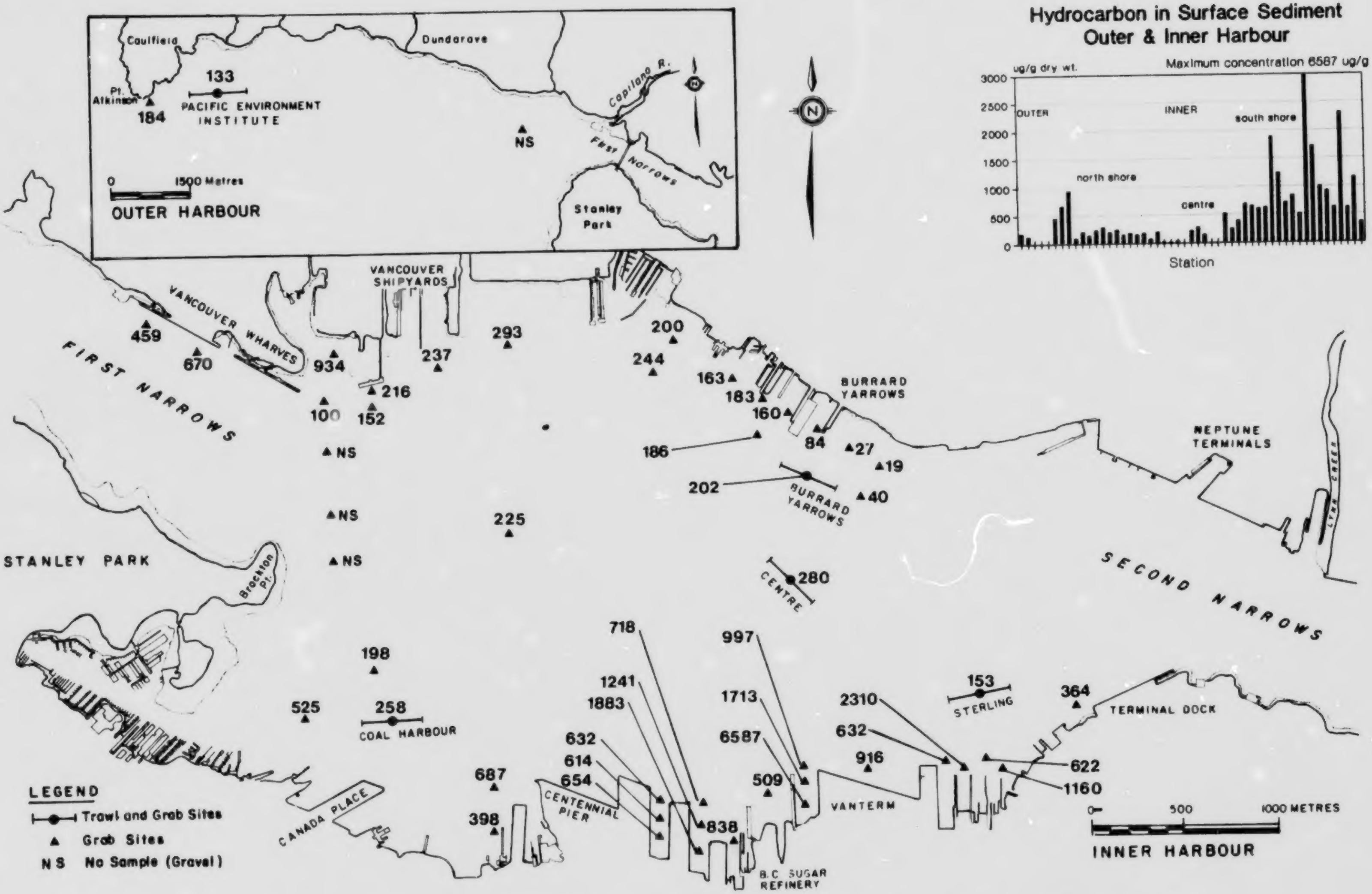
Hydrocarbon in Surface Sediment
Outer & Inner Harbour
ug/g dry wt.
Maximum concentration 6587 ug/g
3000
2500
2000
1500
1000
500
0
OUTER
INNER
north shore
centre
south shore
Station
Coulfield
Dundarave
133
Pt. Atkinson
184
PACIFIC ENVIRONMENT INSTITUTE
NS
Capilano R.
First Narrows
Stanley Park
0
1500 Metres
OUTER HARBOUR
N
VANCOUVER WHARVES
VANCOUVER SHIPYARDS
FIRST NARROWS
459
670
934
100
216
152
237
293
200
244
163
183
160
84
27
19
40
186
202
BURRARD YARROWS
NEPTUNE TERMINALS
LYNN CREEK
NS
NS
NS
225
STANLEY PARK
Brockton Pt.
CENTRE
280
SECOND NARROWS
198
525
258
COAL HARBOUR
718
1241
1883
632
614
654
687
398
CENTENNIAL PIER
CANADA PLACE
838
B.C. SUGAR REFINERY
997
1713
6587
509
VANTERM
916
2310
632
153
STERLING
364
TERMINAL DOCK
622
1160
0
500
1000 METRES
INNER HARBOUR
LEGEND
Trawl and Grab Sites
Grab Sites
NS No Sample (Gravel)

FIGURE 3a Mean Surface Sediment Hydrocarbon Concentrations in μg/g Dry Weight (1985-86) - Outer and Inner Harbour

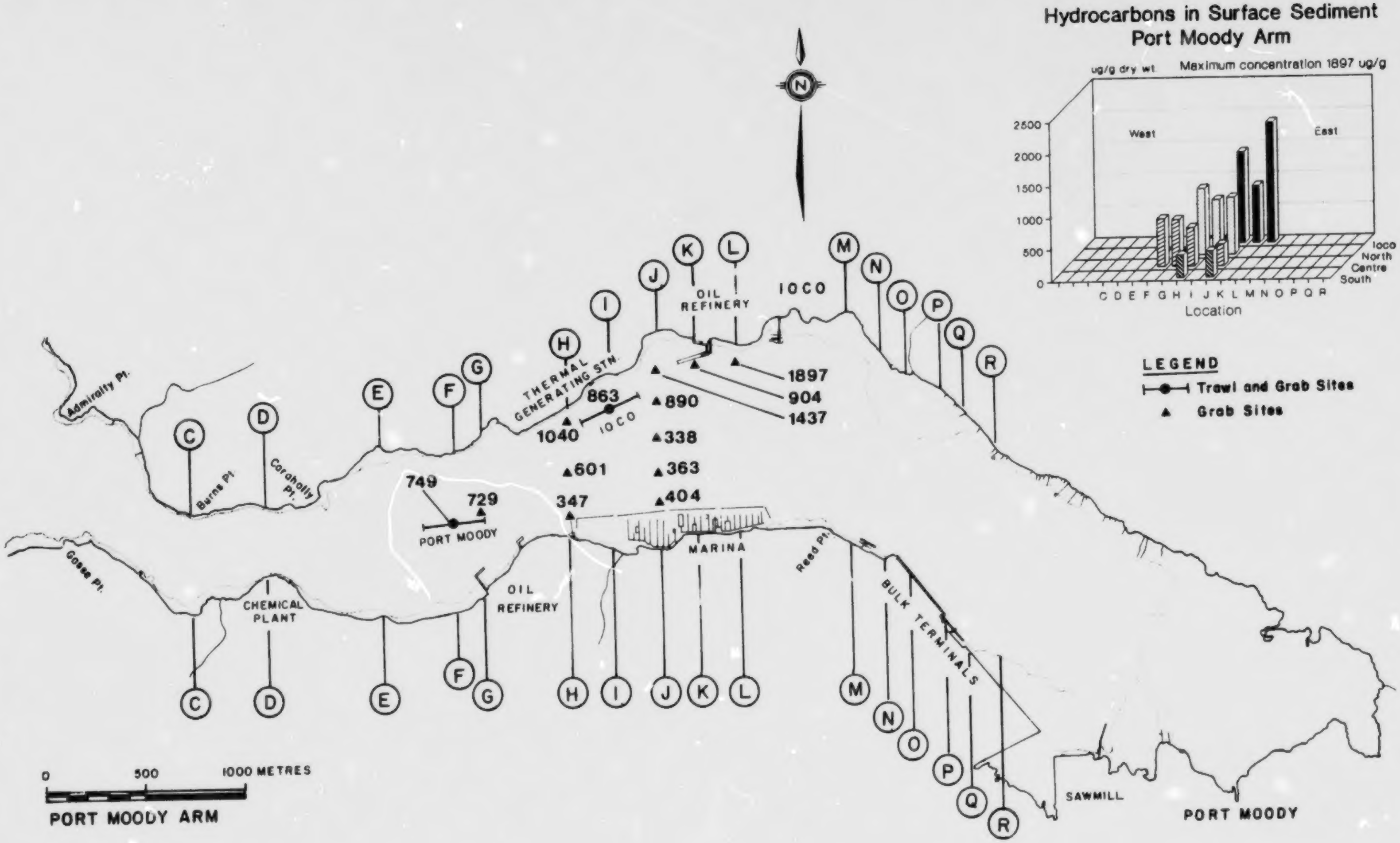
Hydrocarbons in Surface Sediment
Port Moody Arm
ug/g dry wt
Maximum concentration 1897 ug/g
2500
2000
1500
1000
500
0
West
East
C D E F G H I J K L M N O P Q R
Location
Ioco
North
Centre
South
LEGEND
Trawl and Grab Sites
Grab Sites
Admiralty Pt.
Burns Pt.
Carraholly Pt.
Gosse Pt.
CHEMICAL PLANT
OIL REFINERY
THERMAL GENERATING STN.
IOCO
OIL REFINERY
MARINA
Reed Pt.
BULK TERMINALS
SAWMILL
PORT MOODY
C
D
E
F
G
H
I
J
K
L
M
N
O
P
Q
R
1897
904
1437
890
338
363
404
863
1040
601
347
749
729
0
500
1000 METRES
PORT MOODY ARM

FIGURE 3b Mean Surface Sediment Hydrocarbon Concentrations in µg/g Dry Weight (1985 - 86) - Port Moody Arm

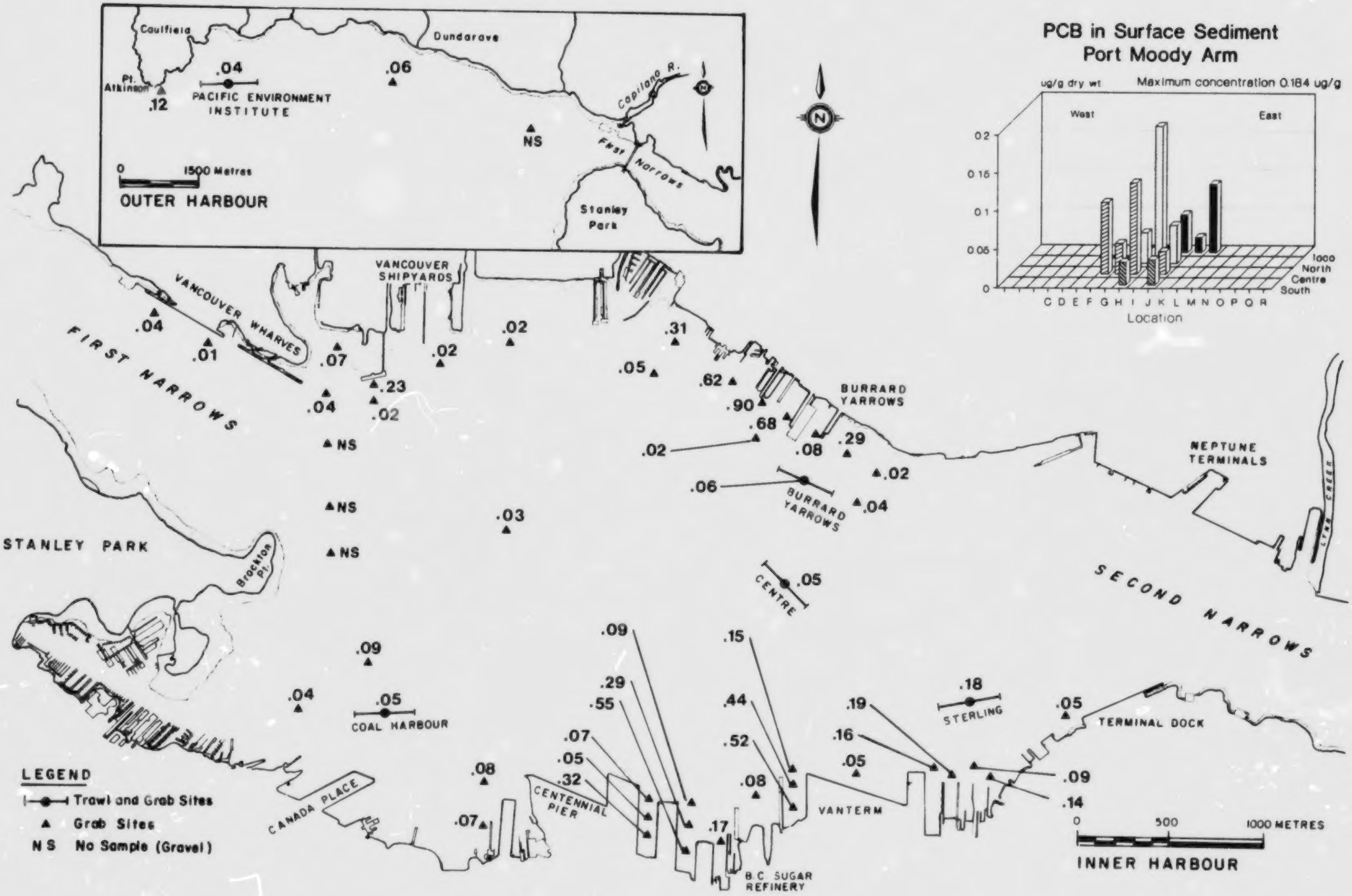
Caulfield
Dundarave
Pt. Atkinson
.12
.04
PACIFIC ENVIRONMENT INSTITUTE
.06
NS
Capilano R.
First Narrows
Stanley Park
0
1500 Metres
OUTER HARBOUR
PCB in Surface Sediment
Port Moody Arm
ug/g dry wt
Maximum concentration 0.184 ug/g
West
East
0.2
0.15
0.1
0.05
0
C D E F G H I J K L M N O P Q R
Location
Ioco
North
Centre
South
VANCOUVER WHARVES
VANCOUVER SHIPYARDS
FIRST NARROWS
STANLEY PARK
Brockton Pt.
.04
.01
.07
.04
.23
.02
.02
.02
NS
NS
NS
.03
.05
.31
.62
.90
.68
.02
.08
.29
.02
.04
.06
BURRARD YARROWS
BURRARD YARROWS
NEPTUNE TERMINALS
LYNN CREEK
SECOND NARROWS
.05
CENTRE
.09
.04
.05
COAL HARBOUR
.08
.07
CANADA PLACE
CENTENNIAL PIER
.09
.29
.55
.07
.05
.32
.17
.15
.44
.52
.08
B.C. SUGAR REFINERY
VANTERM
.19
.16
.05
.18
STERLING
.05
TERMINAL DOCK
.09
.14
0
500
1000 METRES
INNER HARBOUR
LEGEND
Trawl and Grab Sites
▲ Grab Sites
NS No Sample (Gravel)

FIGURE 4a Mean Surface Sediment Polyclorinated Biphenyl (PCB) Concentrations in µg/g Dry Weight (1985-86) - Outer and inner Harbour

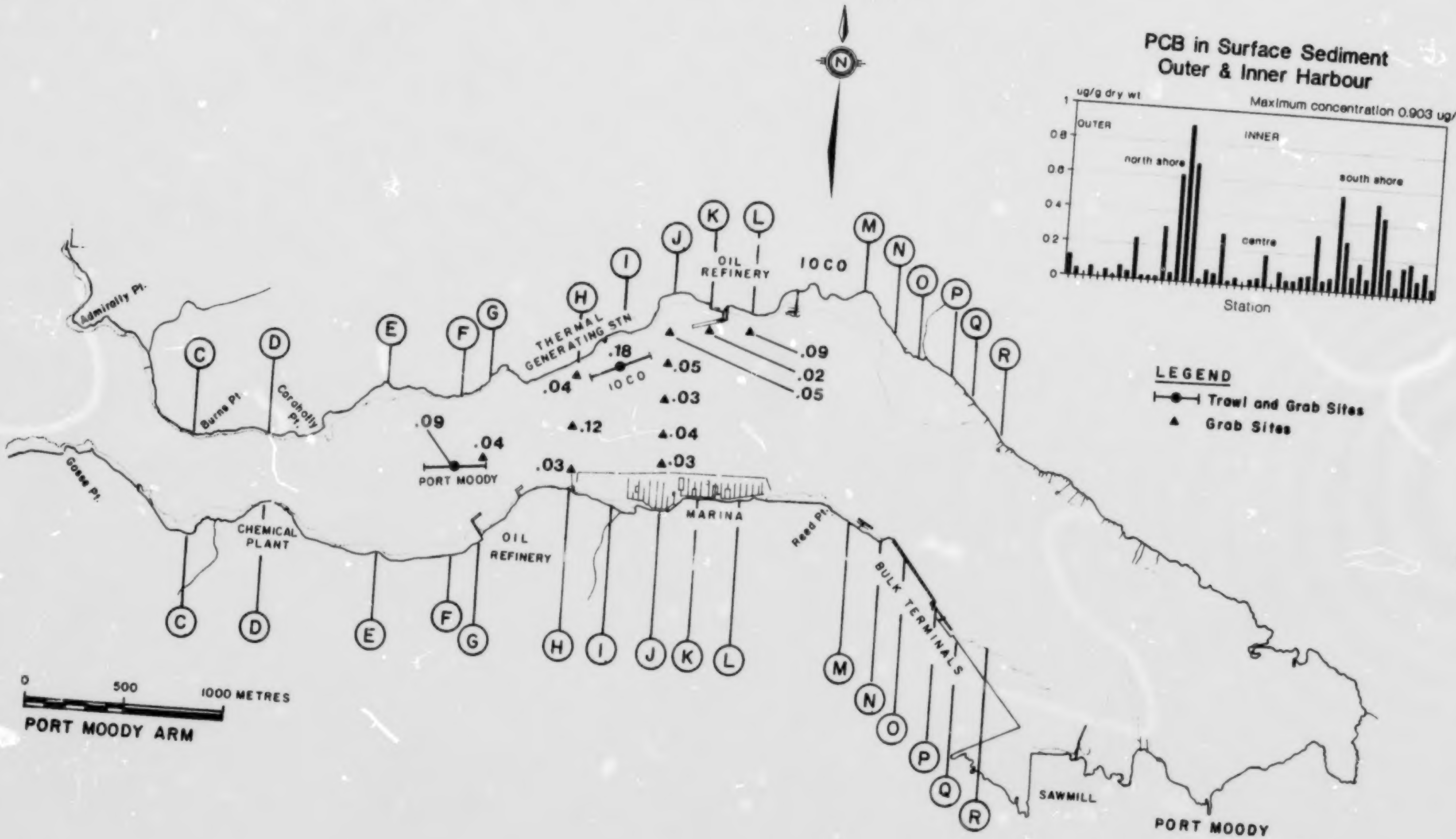
PCB in Surface Sediment
Outer & Inner Harbour
ug/g dry wt
Maximum concentration 0.903 ug/g
1
0.8
0.6
0.4
0.2
0
OUTER
INNER
north shore
centre
south shore
Station
LEGEND
Trawl and Grab Sites
Grab Sites
N
Admiralty Pt.
Burns Pt.
Caraholly Pt.
Gosse Pt.
CHEMICAL PLANT
OIL REFINERY
THERMAL GENERATING STN
IOCO
OIL REFINERY
MARINA
Reed Pt.
BULK TERMINALS
SAWMILL
PORT MOODY
PORT MOODY
C
D
E
F
G
H
I
J
K
L
M
N
O
P
Q
R
.09
.04
.03
.04
.18
.12
.05
.03
.04
.03
.09
.02
.05
0
500
1000 METRES
PORT MOODY ARM

FIGURE 4b Mean Surface Sediment Polychlorinated Biphenyl (PCB) Concentrations in µg/g Dry Weight (1985-86) - Port Moody Arm

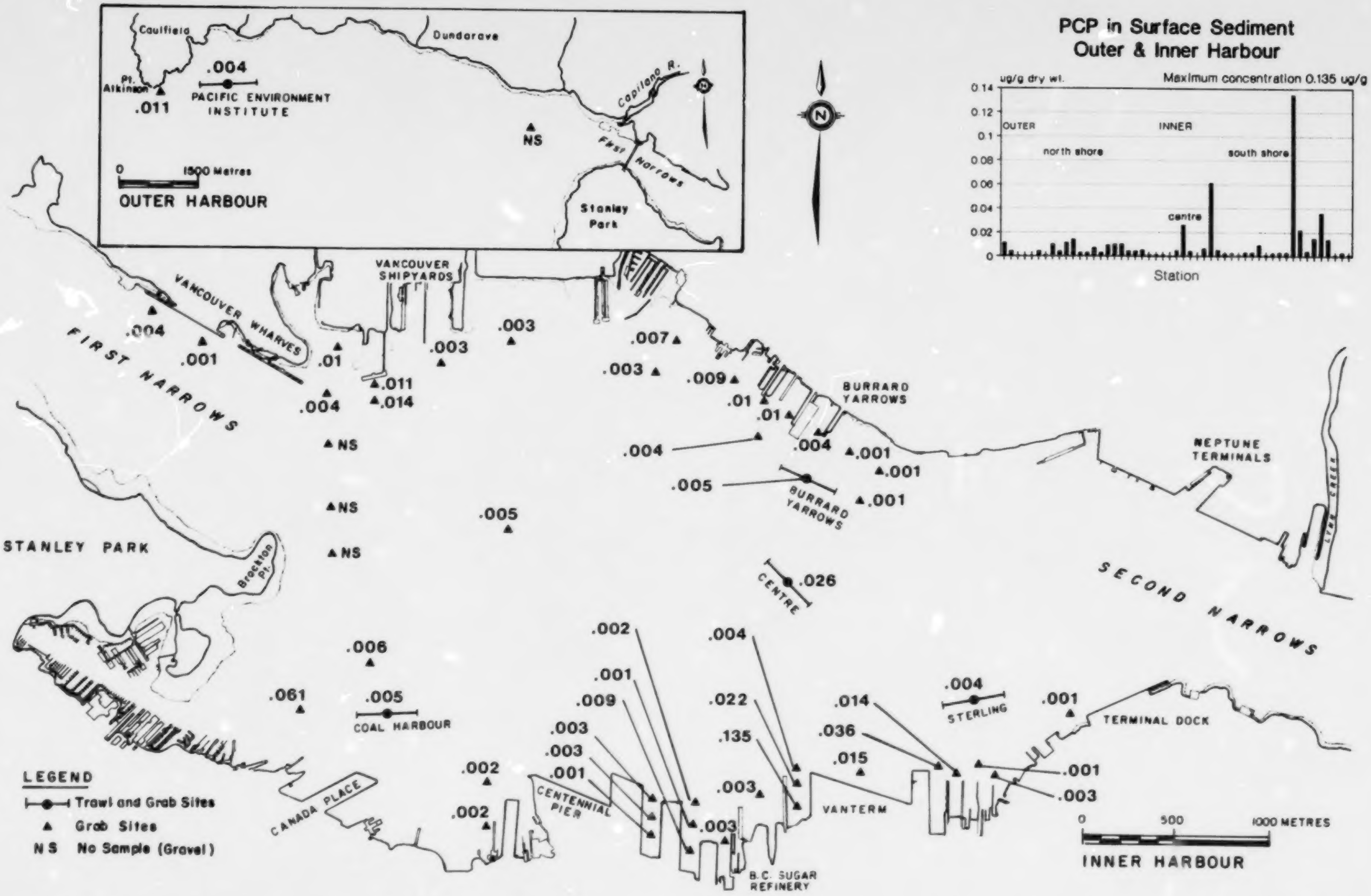
Caulfield
Dundarave
Pt. Atkinson
.011
.004
PACIFIC ENVIRONMENT INSTITUTE
NS
Capilano R.
First Narrows
Stanley Park
0
1500 Metres
OUTER HARBOUR
PCP in Surface Sediment
Outer & Inner Harbour
ug/g dry wt.
Maximum concentration 0.135 ug/g
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
OUTER
INNER
north shore
centre
south shore
Station
VANCOUVER WHARVES
VANCOUVER SHIPYARDS
FIRST NARROWS
.004
.001
.01
.004
.011
.014
.003
.003
NS
NS
NS
.005
.007
.003
.009
.01
.01
BURRARD YARROWS
.004
.004
.001
.001
.001
.005
BURRARD YARROWS
NEPTUNE TERMINALS
LYNN CREEK
.026
CENTRE
SECOND NARROWS
STANLEY PARK
Brockton Pt.
.006
.061
.005
COAL HARBOUR
.002
.002
CANADA PLACE
CENTENNIAL PIER
.002
.001
.009
.003
.003
.001
.003
.004
.022
.135
.003
B.C. SUGAR REFINERY
VANTERM
.014
.036
.015
.004
STERLING
.001
TERMINAL DOCK
.001
.003
0
500
1000 METRES
INNER HARBOUR
LEGEND
Trawl and Grab Sites
Grab Sites
NS No Sample (Gravel)

FIGURE 5a Mean Surface Sediment Pentachlorophenol (PCP) Concentrations in µg/g Dry Weight (1985-86) — Outer and Inner Harbour

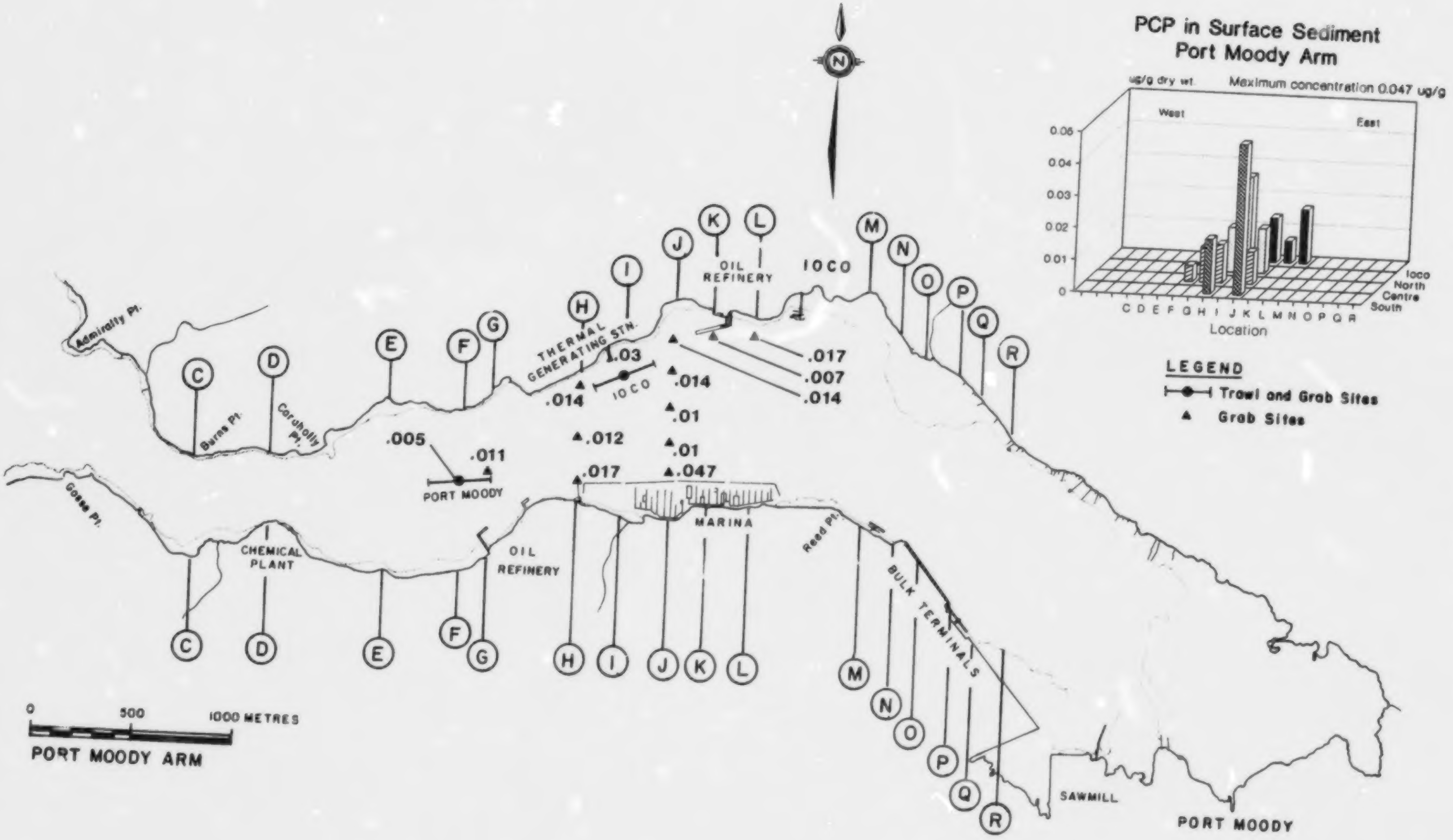
PCP in Surface Sediment
Port Moody Arm
ug/g dry wt
Maximum concentration 0.047 ug/g
West
East
0.05
0.04
0.03
0.02
0.01
0
C D E F G H I J K L M N O P Q R
Location
Ioco
North
Centre
South
LEGEND
Trawl and Grab Sites
▲ Grab Sites
N
Admiralty Pt.
Burns Pt.
Carraholly Pt.
Gosse Pt.
C
D
E
F
G
H
I
J
K
L
M
N
O
P
Q
R
THERMAL GENERATING STN.
OIL REFINERY
IOCO
.017
.007
.014
1.03
.014
.014
.01
.012
.01
.017
.047
.005
.011
PORT MOODY
CHEMICAL PLANT
OIL REFINERY
MARINA
Reed Pt.
BULK TERMINALS
SAWMILL
PORT MOODY
0
500
1000 METRES
PORT MOODY ARM

FIGURE 5b Mean Surface Sediment Pentachlorophenol (PCP) Concentrations in µg/g Dry Weight (1985-86)– Port Moody Arm

TABLE 3 COMPARISON OF SEDIMENT OILS AND GREASE (O&G), HYDROCARBON (HC), POLYCHLORINATED BIPHENYLS (PCB) AND CHLOROPHENOL CONCENTRATIONS BETWEEN FIELD SURVEYS IN VANCOUVER HARBOUR (1985-1986)

	CONCENTRATION (µg/g Dry Weight)				
				CHLOROPHENOLS	
STN	O&G	HC	PCB	PENTA	TETRA
PMI	P=.000 CR=95	P=.000 CR=66	P=.005 CR=.064	P=.000 CR=.002	P=.000 CR=.003
-O85			.070ab		
-J86	254b	240b	.010a	.001a	.001a
-M86	33a	26a	.020a	.005b	.003a
-S86	163b	184b	.099b	.006b	.014b
11B	P=.156 NS	P=.000 CR=67	P=.027 CR=.151	P=.063 NS	P=.414 NS
-O85			.028ab		
-J86	312	214b	.014a	.002	.003
-M86	182	141a	.020a	.009	.003
-S86	193	207ab	.173b	.004	.007
15	P=.012 CR=164	P=.002 CR=129	P=.018 CR=.049	P=.000 CR=.007	P=.000 CR=.010
-J86	433b	429b	.036ab	.058b	.065b
-M86	185a	167a	.020a	.003a	.003a
-S86	300ab	289a	.082b	.009a	.011a
16	P=.050 NS	P=.795 NS	P=.589 NS	P=.050 NS	P=.484 NS
-O85	-	-	.207	-	-
-M86	213a	193	.290	.002	.003
-S86	140a	167	.051	.005	.011

	CONCENTRATION (µg/g Dry Weight)				
				CHLOROPHENOLS	
STN	O&G	HC	PCB	PENTA	TETRA
19	P=.000 CR=176	P=.001 CR=107	P=.004 CR=.036	P=.000 CR=.003	P=.000 CR=.002
-O85	-	-	.071b	-	-
-J86	404b	374b	.021a	.001a	.001a
-M86	245ab	222a	.047ab	.005b	.005b
-S86	220a	227a	.039ab	.008b	.007b
35	P=.000 CR=380	P=.000 CR=155	P=.001 CR=.101	P=.000 CR=.002	P=.003 CR=.004
-O85	-	-	.219b	-	-
-J86	1034b	976c	.025a	.002a	.006a
-M86	541a	494a	.020a	.006b	.006a
-S86	853ab	712b	.088a	.007b	.011b
38 -J86*	1410	1330	.220	.560	.149
	P=.010	P=.007	P=.024	P=.072 NS-1	P=.026
-M86	760A	688A	.20A	.005	.005a
-S86	1087b	890b	.172b	.012	.022b

* ONLY ONE VALUE OBTAINED AT THIS STATION

CR=CRITICAL RANGE (Mean values separated by more than this value are significantly different)

O85=OCTOBER 1985 J86=JANUARY 1986 M86=MAY 1986 S86=SEPTEMBER 1986

Sediment PAH concentrations in Vancouver Harbour are in Table 4 and detailed in Appendix V. Total PAH concentrations are illustrated in Figure 6. Out of 23 stations, total PAH concentration ranged between 1.34 and 14.11 µg/g dry weight. Low molecular weight PAH ranged between 0.32 µg/g and 7.51 µg/g; high molecular weight PAH, between 1.02 µg/g and 8.82 µg/g (Table 4).

Although the analysis was conducted on triplicate samples per station, analytical precision was not confirmed by internal duplicates. In a number of cases, the variation between field replicates was larger than would be expected in replicate samples (Appendix V). In the case of Laboratory B, samples were periodically analyzed in duplicate (labelled A & B). The agreement between the internal lab duplicates and between the field replicates was acceptable (Appendix IV & V). Results from blind splits taken from two sampling locations showed large differences between Laboratory A and B (Appendix III). Results from both laboratories have been given but those from Laboratory A should be considered preliminary until confirmed with additional field samples.

TABLE 4 MEAN SEDIMENT POLYCYCLIC AROMATIC HYDROCARBON (PAH) CONCENTRATIONS (μg/g DRY WEIGHT) - VANCOUVER HARBOUR (1985 - 1986).

				LOW MOLECULAR WEIGHT (MW) PAH					HIGH MOLECULAR WEIGHT (MW) PAH							
STATION	TOTAL PAH	LOW MW PAH	HIGH MW PAH	NAPTHALENE	ACENAPHTHYLENE	ACENAPHTHENE	ANTH./ PHEN.	FLUORENE	FLUORANTH.	PYRENE	CHRYSENE/ BENZO(a) ANTH.	BENZO(k)/(b) FLUORANTHENE	BENZO(a) PYRENE	BENZO(ghi) PERYLENE	DIBENZO (ah)ANTH.	INDENO (1,2,3cd) PYRENE
PEI**	1.45	.32	1.13	<.01	.02	.02	.21	.07	.20	.20	.20	.24	.06	.11	.04	.08
1*	7.46	2.78	4.68	.13	<.18	.34	.28/1.72	.31	1.75	1.12	.67/.50	.35/.29	<.13	<.21	<.13	<.19
2*	1.03	.32	.71	<.08	<.18	<.10	<.10/.32	<.10	.29	.14	.28/<.10	<.24/<.13	<.13	<.21	<.13	<.19
3A**	12.24	3.42	8.82	<.01	.02	.21	2.64	.55	3.10	2.10	1.08	1.24	.23	.42	.20	.45
3B**	2.62	.78	1.84	<.01	<.01	.05	.62	.11	.42	.63	.24	.29	.05	.08	.04	.09
4A**	7.13	1.80	5.33	.10	.01	.13	1.32	.24	1.79	1.91	.49	.60	.12	.16	.08	.18
14**	1.59	.43	1.16	<.01	.03	.03	.28	.09	.24	.26	.15	.23	.05	.10	.09	.04
15**	2.54	.75	1.79	.08	.02	.03	.44	.18	.33	.33	.27	.38	.09	.16	.07	.16
16**	4.92	1.34	3.58	.10	.10	.06	.90	.18	.66	.83	.58	.67	.18	.32	.14	.20
17**	5.68	1.43	4.25	.08	.08	.07	1.02	.18	.88	.94	.64	.82	.19	.32	.14	.32
19**	7.04	1.55	5.49	.14	.08	.10	1.02	.21	1.20	1.16	.87	1.08	.26	.44	.20	.28
21A**	4.22	2.21	2.01	.25	<.01	.06	1.68	.22	.98	.75	.28	<.01	<.01	<.01	<.01	<.01
22A**	14.11	7.51	6.60	1.17	<.01	.14	5.20	1.00	3.00	2.20	1.40	<.01	<.01	<.01	<.01	<.01

TABLE 4 (CONT'D) SEDIMENT POLYCYCLIC AROMATIC HYDROCARBON (PAH) CONCENTRATIONS ($\mu g/g$ DRY WEIGHT) - VANCOUVER HARBOUR (1985 - 1986).

				LOW MOLECULAR WEIGHT (MW) PAH					HIGH MOLECULAR WEIGHT (MW) PAH							
STATION	TOTAL PAH	LOW MW PAH	HIGH MW PAH	NAPTHA-LENE	ACENAPH-THYLENE	ACENAPH-THENE	ANTH./ PHEN.	FLUOR-ENE	FLUOR-ANTH.	PYRENE	CHRYSENE/ BENZO(a) ANTH.	BENZO(k)/(b) FLUORANTHENE	BENZO(a) PYRENE	BENZO(ghi) PERYLENE	DIBENZO (ah)ANTH.	INDENO (1,2,3cd) PYRENE
23**	5.23	2.58	2.65	.35	<.01	.03	1.95	.25	1.25	1.05	.35	<.01	<.01	<.01	<.01	<.01
24**	2.89	1.39	1.50	.12	<.01	.04	1.12	.12	.77	.55	.18	<.01	<.01	<.01	<.01	<.01
25A**	4.97	2.57	2.40	.30	<.01	.07	2.00	.20	1.15	.95	.30	<.01	<.01	<.01	<.01	<.01
28*	4.87	1.37	3.50	.29	<.18	<.10	.16/.77	.15	.85	.84	.99/82	<.24/<.13	<.13	<.21	<.13	<.19
30*	9.53	3.73	5.80	.39	<.18	<.10	.61/2.30	.43	1.27	1.12	1.30/1.28	.83	<.13	<.21	<.13	<.19
35**	2.94	.71	2.23	.03	.08	.03	.46	.11	.40	.48	.22	.50	.10	.21	.10	.22
39C**	3.48	1.02	2.46	.05	.14	.04	.65	.14	.43	.57	.29	.40	.10	.33	.10	.24
39D**	3.86	1.31	2.55	.13	.23	.04	.77	.14	.45	.60	.42	.36	.11	.31	.08	.22
39E**	3.22	.88	2.34	.03	.12	.03	.59	.11	.49	.59	.29	.41	.08	.22	.08	.18
40**	4.93	1.84	3.09	.24	.14	.12	1.07	.27	.50	1.19	.47	.41	.12	.18	.07	.15
41**	4.83	1.15	3.68	<.01	.11	.05	.81	.18	.60	.84	.51	.71	.16	.40	.15	.31

Note: Totals exclude "less than" mean values (see Appendix V)

* Analysis by LABORATORY A
** Analysis by LABORATORY B

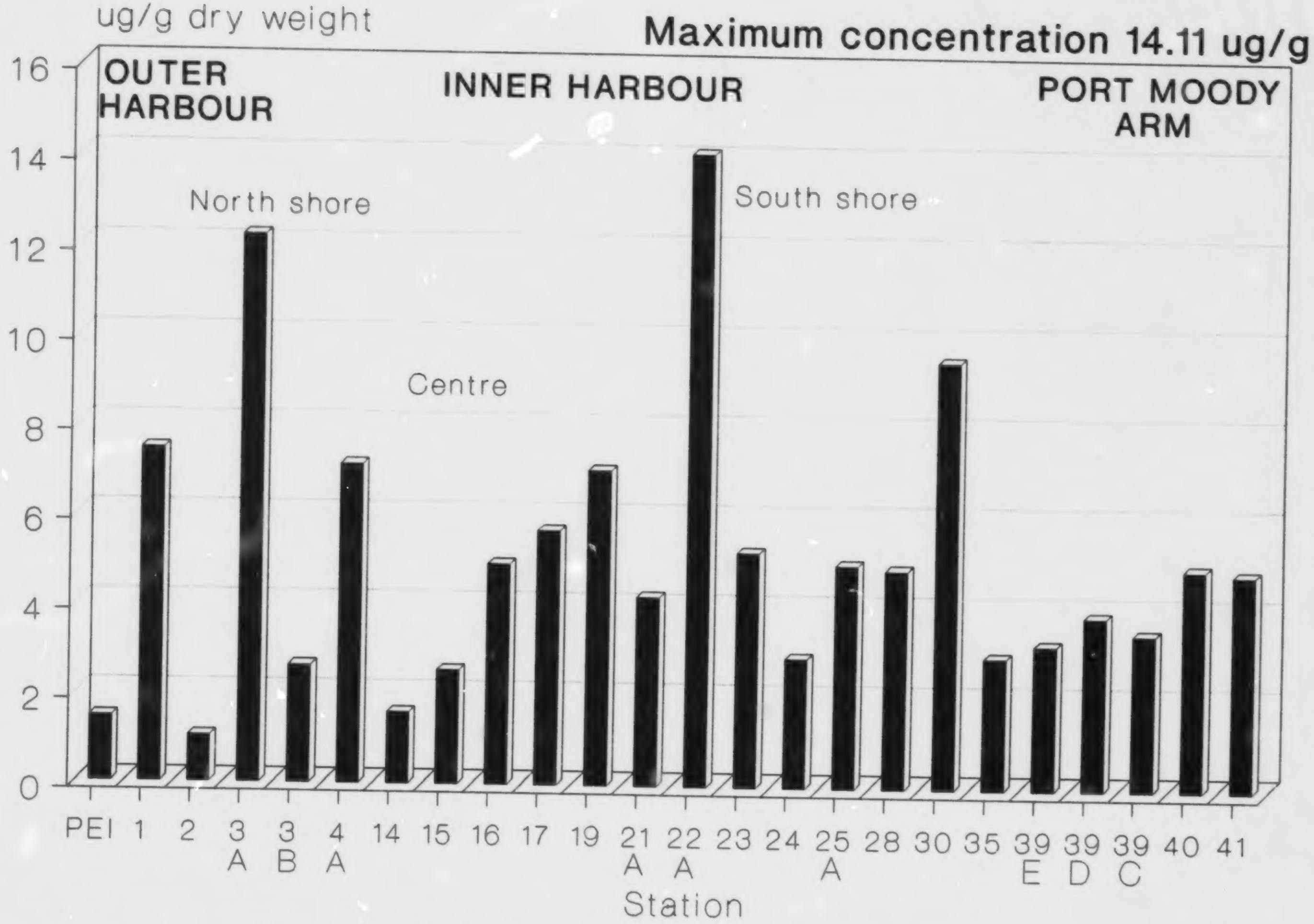

FIGURE 6 TOTAL SEDIMENT POLYCYCLIC AROMATIC HYDROCARBON (PAH) CONCENTRATIONS (UG/G DRY WEIGHT) - VANCOUVER HARBOUR (1985-86)

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APPENDIX I

VANCOUVER HARBOUR SAMPLING STATION COORDINATES AND DEPTHS 1985 - 1986

APPENDIX I VANCOUVER HARBOUR SAMPLING STATION COORDINATES AND DEPTHS (1985-86)

AREA	STATION	SURVEY	LATITUDE	LONGITUDE	DEPTH(m)
OUTER HARBOUR					
	SB	May 85	49°18.23'N	123°13.78'W	55
	ATK	Sep 86	49°19.67'N	123°15.80'W	60
	PEI (Trawl)	May 85	49°19.80'N	123°13.73'W	59
		Oct 85	49°19.75'N	123°13.95'W	68
		Jan 86	49°19.55'N	123°13.92'W	67
		May 86	49°19.77'N	123°13.90'W	60
		Sep 86	49°19.80'N	123°13.94'W	58
	DD	Oct 85	49°19.70'N	123°11.65'W	25
INNER HARBOUR					
North Shore	1	Jun 86	49°18.72'N	123°07.45'W	13
	2	Jun 86	49°18.65'N	123°07.27'W	12
	3A	Sep 86	49°18.73'N	123°06.62'W	12
	3B	Sep 86	49°18.48'N	123°06.67'W	14
	4A	Nov 85	49°18.50'N	123°06.48'W	20
	4B	Sep 86	49°18.40'N	123°06.50'W	21
	5	Nov 85	49°18.58'N	123°06.21'W	24
	6	Nov 85	49°18.62'N	123°05.90'W	27
	7A	Nov 85	49°18.63'N	123°05.15'W	20
	7B	Nov 85	49°18.53'N	123°05.25'W	27
	8	Nov 85	49°18.52'N	123°04.89'W	16
	9	Nov 85	49°18.45'N	123°04.76'W	20
	10A	Nov 85	49°18.39'N	123°04.70'W	22
	10B	Nov 85	49°18.35'N	123°04.50'W	28
	11A	Nov 85	49°18.35'N	123°04.53'W	20
	11B (Trawl)	May 85	49°18.12'N	123°04.45'W	21
		Oct 85	49°18.10'N	123°04.40'W	23
		Jan 86	49°18.27'N	123°04.88'W	26
		May 86	49°18.30'N	123°04.88'W	28
		Sep 26	49°18.37'N	123°04.87'W	24
	12	Nov 85	49°18.27'N	123°04.39'W	24
	13A	Nov 85	49°18.23'N	123°04.27'W	24
	13B	Nov 85	49°18.26'N	123°04.18'W	26
Centre	14	Sep 86	49°18.10'N	123°05.83'W	25
	15 (Trawl)	Jan 86	49°18.01'N	123°05.07'W	43
		May 86	49°17.61'N	123°04.60'W	30
		Sep 86	49°17.95'N	123°05.00'W	18
	16 (Trawl)	May 85	49°17.60'N	123°03.87'W	21
		Oct 85	49°17.60'N	123°03.80'W	29
		May 86	49°17.60'N	123°03.87'W	20
		Sep 86	49°17.63'N	123°03.73'W	19

APPENDIX I VANCOUVER HARBOUR SAMPLING STATION COORDINATES AND DEPTHS (1985-86) (CONTINUED)

AREA	STATION	SURVEY	LATITUDE	LONGITUDE	DEPTH(m)
South Shore	17	Sep 86	49°17.70'N	123°06.50'W	17
	18	Jan 86	49°17.41'N	123°06.65'W	14
	19 (Trawl)	May 85	49°17.47'N	123°06.15'W	18
		Oct 85	49°17.29'N	123°06.17'W	18
		Jan 86	49°17.47'N	123°06.30'W	18
		May 86	49°17.47'N	123°06.15'W	20
		Sep 86	49°17.48'N	123°06.28'W	19
	20A	Jun 86	49°17.22'N	123°05.99'W	14
	20B	Jun 86	49°17.35'N	123°05.99'W	18
	21A	Jun 86	49°17.16'N	123°05.77'W	14
	21B	Jun 86	49°17.23'N	123°05.77'W	20
	21C	Jun 86	49°17.30'N	123°05.77'W	28
	22A	Jun 86	49°17.15'N	123°05.08'W	13
	22B	Jun 86	49°17.20'N	123°05.08'W	18
	22C	Jun 86	49°17.28'N	123°05.08'W	28
	23	Jun 86	49°17.20'N	123°04.94'W	19
	24	Jun 86	49°17.32'N	123°04.78'W	22
	25A	Jun 86	49°17.28'N	123°04.54'W	32
	25B	Jun 86	49°17.33'N	123°04.54'W	29
	25C	Jun 86	49°17.38'N	123°04.54'W	26
	26	Jun 86	49°17.37'N	123°04.33'W	26
	27	Jun 86	49°17.41'N	123°03.99'W	14
	28	Jun 86	49°17.36'N	123°03.84'W	17
	29	Jun 86	49°17.41'N	123°03.81'W	21
	30	Jun 86	49°17.37'N	123°03.73'W	13
	31	Jun 86	49°17.60'N	123°03.40'W	29
CENTRAL HARBOUR					
	CP	May 85	49°17.95'N	122°57.78'W	28
	BR	May 85	49°18.20'N	122°56.36'W	32
EASTERN HARBOUR					
Port Moody Arm	32	May 85	49°17.49'N	122°55.00'W	20
	33A	May 85	49°17.47'N	122°54.66'W	22
	33B	May 85	49°17.49'N	122°54.70'W	32
	34	May 85	49°17.49'N	122°54.25'W	17
	35 (Trawl)	May 85	49°17.61'N	122°53.83'W	17
		Oct 85	49°17.62'N	122°53.78'W	15
		Jan 86	49°17.61'N	122°53.81'W	18
		May 86	49°17.64'N	122°53.80'W	18
		Sep 86	49°17.61'N	122°53.85'W	16
	36	Nov 85	49°17.70'N	122°53.70'W	17
	37A	Nov 85	49°17.83'N	122°53.40'W	15
	37B	Nov 85	49°17.70'N	122°53.43'W	15
	37C	Nov 85	49°17.56'N	122°53.42'W	15

APPENDIX I VANCOUVER HARBOUR SAMPLING STATION COORDINATES AND DEPTHS (1985-86)

AREA	STATION	SURVEY	LATITUDE	LONGITUDE	DEPTH(m)
	38	Jan 86	49°17.95'N	122°53.10'W	12
		May 86	49°17.95'N	122°53.15'W	14
		Sep 86	49°17.91'N	122°53.10'W	15
	39A	Nov 85	49°18.00'N	122°53.02'W	10
	39B	May 85	49°17.90'N	122°53.02'W	12
	39C	Nov 85	49°17.80'N	122°53.02'W	12
	39D	Nov 85	49°17.70'N	122°53.02'W	13
	39E	Nov 85	49°17.60'N	122°53.02'W	13
	40	Nov 85	49°17.95'N	122°52.90'W	12
	41	Nov 85	49°17.95'N	122°52.70'W	8
	42	May 85	49°17.61'N	122°52.23'W	13
	43	May 85	49°17.56'N	122°52.11'W	13
	44	May 85	49°17.50'N	122°51.98'W	14
	45	May 85	49°17.45'N	122°51.85'W	14
	46	May 85	49°17.39'N	122°51.73'W	14
	47	May 85	49°17.35'N	122°51.60'W	11

Note: (Trawl) denotes sediment sampling stations corresponding to otter trawl sampling sites (biota sampling).

APPENDIX II

SEDIMENT ORGANICS - RAW DATA

OILS AND GREASE, HYDROCARBON, POLYCHLORINATED BIPHENYLS AND CHLOROPHENOL CONCENTRATIONS - VANCOUVER HARBOUR (1985-1986)

APPENDIX II **SEDIMENT ORGANICS - OILS AND GREASE, HYDROCARBON, POLYCHLORINATED BIPHENYLS AND CHLOROPHENOL CONCENTRATIONS - VANCOUVER HARBOUR (1985-1986)**

	CONCENTRATION (μg/g Dry Weight)					
				CHLOROPHENOLS		
STN	O&G	HC	PCB	PENTA	TETRA	TRI
ATK	200	162*	.080	.011	.006	<.003
	200	162*	.138	.007	.023	<.003
	280	227*	.141	.008	.040	<.003
PKI-J86	267	253	.012	.0002	.001	<.0003
	290	268	.009	.001	.002	<.0003
	205	200	.009	.001	.002	<.0003
-M86	26	21	<.020	.005	.003	
	34	27	<.020	.005	.003	
	39	31	<.020	.005	.003	
-S86	160	130*	.148	.007	.016	<.003
	190	154*	.106	.005	.013	<.003
	140	114*	.042	.007	.012	<.003
1	829	823	.096	.002	.007	<.0003
	62	35	.023	.003	.005	<.0003
	541	520	.009	.007	.034	<.0003
2	362	356	.035	.002	.009	<.0003
	70	53	.003	.001	.005	<.0003
	1650	1600	.001	.001	.003	<.0003
3A	1300	1056*	.048	.013	.018	<.003
	1000	812*	.075	.010	.020	<.003
	-	-	.086	.008	.021	<.003
3B	130	106*	.020	.004	.009	<.003
	77	63*	.019	.004	.007	<.003
	160	130*	.083	.004	.010	<.003

	CONCENTRATION (μg/g Dry Weight)					
				CHLOROPHENOLS		
STN	O&G	HC	PCB	PENTA	TETRA	TRI
4A	87	71*	.314	.004	.010	<.003
	250	203*	.249	.007	.025	<.003
	460	374*	.142	.022	.011	<.003
4B	145	105	<.020	.004	.009	<.001
	311	199	<.020	.023	.004	<.001
5	387	297	<.020	.004	.004	<.001
	377	197	<.020	.004	.005	<.001
	437	216	<.020	.001	.001	<.001
6	408	303	<.020	.005	.004	<.001
	390	299	<.020	.003	.003	<.001
	345	278	.030	.003	.003	<.001
7A	410	219	.210	.006	.005	<.001
	329	174	.300	.007	.007	<.001
	294	208	.420	.008	.008	<.001
7B	296	211	.030	.002	.003	<.001
	451	351	<.020	.003	.003	<.001
	241	169	.090	.003	.002	<.001
8	273	146	.870	.006	.006	<.001
	333	184	.790	.015	.013	<.001
	311	160	.190	.005	.004	<.001
9	382	242	1.170	.010	.009	<.001
	330	206	1.090	.011	.010	<.001
	197	102	.450	.010	.006	<.001

APPENDIX II (CONT'D) SEDIMENT ORGANICS - OILS AND GREASE, HYDROCARBON, POLYCHLORINATED BIPHENYLS AND CHLOROPHENOL CONCENTRATIONS - VANCOUVER HARBOUR (1985-1986)

	CONCENTRATION (µg/g Dry Weight)					
				CHLOROPHENOLS		
STN	O&G	HC	PCB	PENTA	TETRA	TRI
10A	373	247	.620	.012	.006	<.001
	170	95	.790	.009	.005	<.001
	212	137	.640	.008	.006	<.001
10B	305	195	<.020	.003	.005	<.001
	217	161	<.020	.005	.003	<.001
	329	202	<.020	.003	.002	<.001
11A	95	44	.060	.007	.003	<.001
	168	119	.050	.004	<.001	<.001
	305	89	.120	<.001	<.001	<.001
11B-O85			.024			
			.048			
			.011			
-J86	306	299	.010	.001	.001	<.0003
	313	312	.012	.004	.005	<.0003
	316	310	.020	.002	.003	<.0003
-M86	202	166	<.020	.002	.002	
	204	146	<.020	.023	.003	
	139	111	<.020	.001	.003	
-S86	200	162*	.106	.004	.013	<.003
	140	114*	.098	.005	.005	<.003
	240	195*	.314	.004	.002	<.003
12	32	23	.020	<.001	<.001	<.001
	66	33	.050	.001	.002	<.001
	46	24	.800	.001	.001	<.001
13A	35	10	.020	<.001	<.001	<.001
	78	43	.030	<.001	<.001	<.001
	<5	<5	<.020	<.001	<.001	<.001
13B	108	46	.080	.001	.001	<.001
	52	35	<.020	.002	.002	<.001
	76	40	<.020	.001	.001	<.001
14	250	203*	.042	.006	.003	<.003
	310	252*	.029	.004	.002	<.003
	270	219*	.030	.005	.002	<.003
15-J86	391	387	.022	.055	.068	<.0003
	451	450	.042	.057	.058	<.0003
	456	450	.045	.063	.070	<.0003
-M86	182	167	<.020	.002	.002	
	217	181	<.020	.004	.004	
	186	154	.020	.002	.002	
-S86	190	154*	.075	.009	.010	<.003
	310	252*	.117	.011	.011	<.003
	400	325*	.055	.006	.013	<.003
16-O85			.210			
			.360			
			.052			
-M86	178	151	.120	.002	.003	
	225	206	.050	.002	.004	
	236	222	.700	.002	.003	

APPENDIX II (CONT'D) SEDIMENT ORGANICS - OILS AND GREASE, HYDROCARBON, POLYCHLORINATED BIPHENYLS AND CHLOROPHENOL CONCENTRATIONS
- VANCOUVER HARBOUR (1985-1986)

STN	CONCENTRATION (µg/g Dry Weight) O&G	HC	PCB	CHLOROPHENOLS PENTA	TETRA	TRI
-S86	210	171*	.048	.004	.003	<.003
	130	106*	.084	.004	.006	<.003
	81	66*	.022	.008	.025	<.003
17	180	146*	.161	.007	.015	<.003
	320	260*	.045	.005	.009	<.003
	230	187*	.067	.006	.006	<.003
18	553	544	.034	.048	.059	<.0003
	539	538	.032	.064	.084	<.0003
	509	493	.065	.071	.094	<.0003
19-O85			.075			
			.052			
			.087			
-J86	427	357	.023	.001	.001	<.0003
	354	352	.023	.001	.001	<.0003
	432	412	.016	.002	.001	<.0003
-M86	240	226	.060	.005	.005	
	200	180	.050	.004	.004	
	294	259	.030	.005	.005	
-S86	280	227*	.044	.009	.006	<.003
	150	122*	.038	.007	.006	<.003
	230	187*	.036	.007	.008	<.003
20A	368	358	.053	.002	.006	<.0003
	448	435	.058	.002	.011	<.0003
	424	401	.111	.003	.011	<.0003

STN	CONCENTRATION (µg/g DRY WEIGHT) O&G	HC	PCB	CHLOROPHENOLS PENTA	TETRA	TRI
20B	1370	1370	.122	.0004	.035	<.0003
	376	336	.095	.002	.010	<.0003
	370	355	.036	.002	.010	<.0003
21A	610	365	.485	.001	.010	<.0003
	1070	662	.172	.001	.009	<.0003
	1620	934	.290	.001	.012	<.0003
21B	642	555	.050	.003	.002	.0050
	826	711	-	.005	.006	.0011
	705	575	.060	.001	.003	.0008
21C	554	433	.051	.002	.004	.0049
	779	627	.074	.005	.004	.0027
	951	835	.094	.002	.003	.0010
22A	2460	2100	.622	.006	.019	<.0003
	1840	1650	.454	.019	.026	<.0003
	2280	1900	.579	.002	.009	<.0003
22B	1420	1190	.319	.0005	.005	<.0003
	2100	1690	.327	.001	.009	<.0003
	1320	843	.219	.001	.012	<.0003
22C	1460	1010	.060	.002	.063	<.0003
	880	624	.103	.001	.015	<.0003
	770	521	.099	.003	.015	<.0003
23	1140	962	.236	.004	.008	.0015
	960	805	.187	.004	.007	.0013
	861	748	.078	.001	.006	.0012

APPENDIX II (CONT'D) SEDIMENT ORGANICS - OILS AND GREASE, HYDROCARBON, POLYCHLORINATED BIPHENYLS AND CHLOROPHENOL CONCENTRATIONS
- VANCOUVER HARBOUR (1985-1986)

	CONCENTRATION (µg/g Dry Weight)					
				CHLOROPHENOLS		
STN	O&G	HC	PCB	PENTA	TETRA	TRI
24	764	489	.043	.002	.004	<.0003
	427	403	.098	.004	.005	.0026
	664	636	.108	.004	.005	.0024
25A	10700	8080	.580	.015	.024	.0035
	7230	4680	.724	.015	.027	.0101
	9160	7000	.248	.375	.137	.0599
25B	1620	1460	.456	.008	.025	.0120
	1930	1660	.465	.006	.009	.0008
	2320	2080	.396	.051	.018	.0007
25C	1550	1460	.133	.005	.014	.0076
	733	681	.240	.003	.009	.0008
	947	850	.080	.004	.010	.0048
26	930	922	.047	.041	.046	.0142
	909	898	.061	.0004	.003	.0081
	928	928	.029	.002	.032	.0054
27	632	632	.159	.036	.033	.0132
28	2010	1980	.210	.005	.008	.0018
	2770	2740	.224	.021	.029	.0054
	2220	2210	.120	.015	.034	.0330
29	543	528	.098	.001	.003	<.0003
	741	700	.098	.002	.008	.0143
	657	638	.069	.001	.036	.0121

	CONCENTRATION (µg/g DRY WEIGHT)					
				CHLOROPHENOLS		
STN	O&G	HC	PCB	PENTA	TETRA	TRI
30	1340	1300	.195	.004	.013	.0046
	1200	1140	.127	.003	.006	.0018
	1080	1040	.093	.003	.005	.0022
31	451	364	.054	.001	.001	.0009
35-085	-	-	.068	-	-	-
	-	-	.230	-	-	-
	-	-	.360	-	-	-
-J86	972	899	.019	.002	.006	<.0003
	1060	1020	.036	.001	.006	<.0003
	1070	1010	.021	.002	.003	<.0003
-M86	538	490	<.020	.006	.006	
	543	498	<.020	.005	.006	
			<.020	.006	.003	
-S86	740	601*	.094	.007	.011	<.003
	850	690*	.180	.009	.011	<.003
	970	788*	.063	.006	.012	<.003
36	799	669	.040	.009	.010	<.001
	979	788	.030	.010	.008	<.001
	894	729	.040	.013	.009	<.001
37A	1170	1000	.040	.019	.013	<.001
	1280	1090	.030	.011	.010	<.001
	1200	1030	.050	.013	.014	<.001

APPENDIX II (CONT'D) SEDIMENT ORGANICS - OILS AND GREASE, HYDROCARBON, POLYCHLORINATED BIPHENYLS AND CHLOROPHENOL CONCENTRATIONS - VANCOUVER HARBOUR (1985-1986)

	CONCENTRATION (μg/g Dry Weight)					
				CHLOROPHENOLS		
STN	O&G	HC	PCB	PENTA	TETRA	TRI
37B	583	449	.070	.015	.014	<.001
	796	669	.040	.010	.010	<.001
	800	684	.240	.011	.008	<.001
37C	488	391	.030	.017	.014	<.001
	374	248	.040	.018	.014	<.001
	486	401	.020	.015	.009	<.001
38 -J86	1410	1330	.220	.156	.149	<.0003
-M86	753	694	<.020	.009	.007	-
	876	743	<.020	.005	.007	-
	650	628	<.020	.001	.0002	-
-S86	1050	853*	.257	.009	.031	<.003
	1140	926*	.113	.012	.018	<.003
	1070	869*	.147	.015	.017	<.003
39A	1730	1550	.020	.012	.009	<.001
	1560	1370	.030	.012	.011	<.001
	1560	1390	.100	.018	.011	<.001

	CONCENTRATION (μg/g DRY WEIGHT)					
				CHLOROPHENOLS		
STN	O&G	HC	PCB	PENTA	TETRA	TRI
39B	910	796	.050	.015	.008	<.001
	1270	1090	.030	.012	.007	<.001
	938	783	.060	.016	.008	<.001
39C	310	216	.030	.009	.006	<.001
	464	409	.020	.009	.006	<.001
	467	389	.040	.011	.008	<.001
39D	130	97	.060	.011	.010	<.001
	578	490	.040	.009	.009	<.001
	578	501	.030	.009	.007	<.001
39E	537	424	.010	.120	.013	<.001
	454	358	.050	.011	.013	<.001
	527	429	.040	.011	.013	<.001
40	1170	1040	<.020	.007	.007	<.001
	801	703	<.020	.004	.003	<.001
	1130	970	<.020	.009	.003	<.001
41	1720	1530	.170	.020	.015	<.001
	2540	2340	.070	.019	.018	<.001
	2010	1820	.030	.011	.012	<.001

O85 = October 1985 J86 = January 1986 M86 = May 1986 S86 = September 1986

* Derived values - Hydrocarbon analysis was not completed on the Sept. 1986 samples. Since the oils and grease analysis is similar, missing data was calculated by taking the mean ratio of HC:O&G from previous survey data (n=169) and applying the factor to the September 1986 oils and grease raw data value. Derived HC = .81 O&G.

APPENDIX III

SEDIMENT POLYCYCLIC AROMATIC HYDROCARBON CONCENTRATIONS - RESULTS FROM INTERLABORATORY BLIND SPLIT SAMPLES

APPENDIX III   SEDIMENT POLYCYCLIC AROMATIC HYDROCARBON CONCENTRATIONS - RESULTS FROM INTERLABORATORY BLIND SPLIT SAMPLES

	CONCENTRATION (μg/g Dry Weight)										
	TOTAL PAH	NAPTHAL-ENE	ACENPAH-THYLENE	ACENAPH-THENE	ANTH./ PHEN.	FLUORENE	FLUOR-ANTHENE	PYRENE	CHRYSENE/ B(a)ANTH.		B(k)+B(b) FLUORANTHENE	BENZO(a) PYRENE
SAMPLE #1												
Laboratory A	7.83	.62	<.18	.31	.20	1.75	<.10	1.90	1.80	<.30	<.3/<.24	<.13
Laboratory B	15.97	1.50	<.01	.40	6.30	-	.40	3.10	2.40	1.20	<.01	<.01
MEAN		1.06	-	.36	3.25	-	-	2.50	2.10	-	-	-
S.D		.44	-	.05	3.05	-	-	.60	.30	-	-	-
SAMPLE #2												
Laboratory A	4.52	<.24	<.54	<.30	<.30	<.8	<.30	<.33	<.30	<.39	<.3/<.39	<.33
Laboratory B	3.81	.40	<.01	.04	1.40	-	.20	.90	.80	.07	<.01	<.01
MEAN		-	-	-	-	-	-	-	-	-	-	-
S.D		-	-	-	-	-	-	-	-	-	-	-

APPENDIX IV

SEDIMENT POLYCYCLIC AROMATIC HYDROCARBONS - RESULTS FROM INTERNAL LABORATORY DUPLICATES BY LABORATORY B IN UG/G DRY WEIGHT

APPENDIX IV SEDIMENT POLYCYCLIC AROMATIC HYDROCARBONS - RESULTS FROM INTERNAL LABORATORY DUPLICATES BY LABORATORY B IN μg/g DRY WEIGHT

Station/ Sample	PEI			16			17		
	A*	B*	X**	A*	B*	X**	A*	B*	X**
Low Molecular Weight PAH									
Naphthalene	<.01	<.01	<.01	.08	.13	.10	.09	.08	.08
Acenaphthylene	.02	.02	.02	.06	.13	.10	.09	.06	.08
Acenaphthene	.02	.02	.02	.06	.05	.06	.08	.06	.07
Anthracene + Phenanthrene	.22	.20	.21	.87	.92	.90	1.29	.74	1.02
Fluorene	.07	.07	.07	.16	.19	.18	.20	.15	.18
High Molecular Weight PAH									
Fluoranthene	.20	.19	.20	.76	.55	.66	1.07	.68	.88
Pyrene	.20	.19	.20	.81	.85	.83	1.10	.78	.94
Chrysene + Benzo(a)anthracene	.20	.19	.20	.64	.51	.58	.81	.46	.64
Benzo(b)fluoranthene + Benzo(k)fluoranthene	.25	.24	.24	.79	.55	.67	.80	.83	.82
Benzo(a)pyrene	.06	.06	.06	.20	.15	.18	.22	.16	.19
Benzo(ghi)perylene	.11	.11	.11	.36	.29	.32	.30	.34	.32
Dibenzo(ah)anthracene	.04	.04	.04	.15	.12	.14	.13	.15	.14
Indeno(1,2,3-cd)pyrene	.09	.08	.08	.18	.22	.20	.30	.35	.32

* A & B = internal laboratory duplicates

** Mean of Lab Duplicates A & B

APPENDIX IV SEDIMENT POLYCYCLIC AROMATIC HYDROCARBONS - RESULTS FROM INTERNAL LABORATORY DUPLICATES BY LABORATORY B IN μg/g DRY WEIGHT

Station/ Sample	19			21A			22A		
	A*	B*	X**	A*	B*	X**	A*	B*	X**
Low Molecular Weight PAH									
Naphthalene	.12	.17	.14	.20	.30	.25	1.10	.90	1.00
Acenaphthylene	.08	.07	.08	<.01	<.01	<.01	<.01	<.01	<.01
Acenapthene	.11	.08	.10	.03	.06	.04	.10	.30	.20
Anthracene + Phenanthrene	1.09	.94	1.02	1.40	1.50	1.45	4.9	4.1	4.5
Fluorene	.23	.19	.21	.20	.20	.20	1.1	.9	1.0
High Molecular Weight PAH									
Fluoranthene	1.09	1.30	1.20	.90	1.00	.95	2.8	2.6	2.7
Pyrene	1.12	1.21	1.16	.70	.80	.75	2.0	1.8	1.9
Chrysene + Benzo(a)anthracene	.90	.84	.87	.04	.05	.04	1.0	.8	.9
Benzo(b)fluoranthene + Benzo(k)fluoranthene	1.01	1.16	1.08	<.01	<.01	<.01	<.01	<.01	<.01
Benzo(a)pyrene	.27	.26	.26	<.01	<.01	<.01	<.01	<.01	<.01
Benzo(ghi)perylene	.41	.48	.44	<.01	<.01	<.01	<.01	<.01	<.01
Dibenzo(ah)anthracene	.18	.21	.20	<.01	<.01	<.01	<.01	<.01	<.01
Indeno(1,2,3-cd)pyrene	.38	.17	.28	<.01	<.01	<.01	<.01	<.01	<.01

* A & B = internal laboratory duplicates ** Mean of Lab Duplicates A & B

APPENDIX V

SEDIMENT POLYCYCLIC AROMATIC HYDROCARBON CONCENTRATIONS UG/G DRY WEIGHT - VANCOUVER HARBOUR 1985 - 1986

APPENDIX V SEDIMENT POLYCYCLIC AROMATIC HYDROCARBON (PAH) CONCENTRATIONS IN UG/G DRY WEIGHT - VANCOUVER HARBOUR 1985 - 1986

LABORATORY A:

Station/	1				2			
Replicates	#1	#2	#3	X*	#1	#2	#3	X*
Low Molecular Weight PAH								
Naphthalene	.10	<.08	.20	.13	<.08	<.08	<.08	<.08
Acenaphthylene	<.18	<.18	<.18	<.18	<.18	<.18	<.18	<.18
Acenaphthene	.44	<.10	.48	.34	<.10	<.10	<.10	<.10
Anthracene	.44	.15	.26	.28	<.10	<.10	<.10	<.10
Phenanthrene	2.97	.30	1.90	1.72	<.21	.33	.42	.32
Fluorene	.47	<.10	.37	.31	<.10	<.10	<.10	<.10
Total Low Molecular Weight PAH				2.78				.32
High Molecular Weight PAH								
Fluoranthene	2.81	.34	2.1	1.75	.33	.27	.28	.29
Pyrene	2.00	.20	1.17	1.12	.15	.15	.11	.14
Chrysene	1.12	.31	.59	.67	.59	<.13	<.13	.28
Benzo(a)anthracene	.88	.27	.36	.50	<.10	<.10	<.10	<.10
Benzo(b)fluoranthene	.56	<.24	<.24	.35	<.24	<.24	<.24	<.24
Benzo(k)fluoranthene	.62	<.13	<.13	.29	<.13	<.13	<.13	<.13
Benzo(a)pyrene	<.13	<.13	<.13	<.13	<.13	<.13	<.13	<.13
Benzo(ghi)perylene	<.21	<.21	<.21	<.21	<.21	<.21	<.21	<.21
Dibenzo(ah)anthracene	<.13	<.13	<.13	<.13	<.13	<.13	<.13	<.13
Indeno(1,2,3-cd)pyrene	<.19	<.19	<.19	<.19	<.19	<.19	<.19	<.19
Total High Molecular Weight PAH				4.68				.71
Total PAH				7.46				1.03

* X = Mean of Replicates 1, 2, & 3 (less than values set equal to detection limit to calculate means except when all replicates are below detection then less than value not included in PAH totals).

APPENDIX V (CONT'D) SEDIMENT POLYCYCLIC AROMATIC HYDROCARBON (PAH) CONCENTRATIONS IN UG/G DRY WEIGHT
- VANCOUVER HARBOUR 1985 - 1986

LABORATORY A:

Station/	28				30			
Replicates	#1	#2	#3	X*	#1	#2	#3	X*
Low Molecular Weight PAH								
Naphthalene	.30	.37	.21	.29	.26	.52	.40	.39
Acenaphthylene	<.18	<.18	<.18	<.18	<.18	<.18	<.18	<.18
Acenaphthene	<.10	<.10	<.10	<.10	<.10	<.10	<.10	<.10
Anthracene	<.10	.12	.25	.16	.36	.33	1.14	.61
Phenanthrene	<.27	1.23	.80	.77	1.34	1.34	4.22	2.30
Fluorene	.25	<.10	<.10	.15	.26	.78	.26	.43
Total Low Molecular Weight PAH				1.37				3.73
High Molecular Weight PAH								
Fluoranthene	.72	1.1	.72	.85	.85	.95	2.00	1.27
Pyrene	.82	1.0	.70	.84	.79	.87	1.7	1.12
Chrysene	.81	1.3	.85	.99	.95	.95	2.0	1.30
Benzo(a)anthracene	.81	1.0	.65	.82	.85	.90	2.1	1.28
Benzo(b)fluoanthene	<.24	<.24	<.24	<.24	<.24	<.24	2.0	.83
Benzo(k)fluoranthene	<.13	<.13	<.13	<.13	<.13	<.13	<.13	<.13
Benzo(a)pyrene	<.13	<.13	<.13	<.13	<.13	<.13	<.13	<.13
Benzo(ghi)perylene	<.21	<.21	<.21	<.21	<.21	<.21	<.21	<.21
Dibenzo(ah)anthracene	<.13	<.13	<.13	<.13	<.13	<.13	<.13	<.13
Indeno(1,2,3-cd)pyrene	<.19	<.19	<.19	<.19	<.19	<.19	<.19	<.19
Total High Molecular Weight PAH				3.50				5.80
Total PAH				4.87				9.53

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* X = Mean of Replicates 1, 2, & 3 (less than values set equal to detection limit to calculate means except when all replicates are below detection then less than value not included in PAH totals).

APPENDIX V (CONT'D) SEDIMENT POLYCYCLIC AROMATIC HYDROCARBON CONCENTRATIONS IN UG/G DRY WEIGHT - VANCOUVER HARBOUR 1985 - 1986

LABORATORY B:

Station/ Replicates	PEI			3A	3B	4A	14	15	16			17		
	1A	1B	#1*	#1	#1	#1	#1	#1	1A	1B	#1*	1A	1B	#1*
Low Molecular Weight PAH														
Naphthalene	<.01	<.01	<.01	<.01	<.01	.10	<.01	.08	.08	.13	.10	.09	.08	.08
Acenaphthylene	.02	.02	.02	.02	<.01	.01	.03	.02	.06	.13	.10	.09	.06	.08
Acenaphthene	.02	.02	.02	.21	.05	.13	.03	.03	.06	.05	.06	.08	.06	.07
Anthracene + Phenanthrene	.22	.20	.21	2.64	.62	1.32	.28	.44	.87	.92	.90	1.29	.74	1.02
Fluorene	.07	.07	.07	.55	.11	.24	.09	.18	.16	.19	.18	.20	.15	.18
Total Low Molecular Weight PAH			.32	3.42	.78	1.80	.43	.75			1.34			1.43
High Molecular Weight PAH														
Fluoranthene	.20	.19	.20	3.10	.42	1.79	.24	.33	.76	.55	.66	1.07	.68	.88
Pyrene	.20	.19	.20	2.10	.63	1.91	.26	.33	.81	.85	.83	1.10	.78	.94
Chrysene + Benzo(a)anthracene	.20	.19	.20	1.08	.24	.49	.15	.27	.64	.51	.58	.81	.46	.64
Benzo(b)fluoranthene + Benzo(k)fluoranthene	.25	.24	.24	1.24	.29	.60	.23	.38	.79	.55	.67	.80	.83	.82
Benzo(a)pyrene	.06	.06	.06	.23	.05	.12	.05	.09	.20	.15	.18	.22	.16	.19
Benzo(ghi)perylene	.11	.11	.11	.42	.08	.16	.10	.16	.36	.29	.32	.30	.34	.32
Dibenzo(ah)anthracene	.04	.04	.04	.20	.04	.08	.09	.07	.15	.12	.14	.13	.15	.14
Indeno(1,2,3-cd)pyrene	.09	.08	.08	.45	.09	.18	.04	.16	.18	.22	.20	.30	.35	.32
High Molecular Weight PAH			1.13	8.82	1.84	5.33	1.16	1.79			3.58			4.25
Total PAH			1.45	12.24	2.62	7.13	1.59	2.54			4.92			5.68

* #1 = Mean of Internal Laboratory Duplicates A & B   NOTE: Totals exclude values below detection limits

APPENDIX V (CONT'D) SEDIMENT POLYCYCLIC AROMATIC HYDROCARBON CONCENTRATIONS IN UG/G DRY WEIGHT - VANCOUVER HARBOUR 1985 - 1986

LABORATORY B:

Station/	19			21A						22A					
Replicates	1A	1B	#1*	1A	1B	#1*	#2	#3	X**	1A	1B	#1*	#2	#3	X
Low Molecular Weight PAH															
Naphthalene	.12	.17	.14	.20	.30	.25	.20	.30	.25	1.10	.90	1.00	1.30	1.20	1.17
Acenaphthylene	.08	.07	.08	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01
Acenapthene	.11	.08	.10	.03	.06	.04	.04	.10	.06	.10	.30	.20	.03	.20	.14
Anthracene + Phenanthrene	1.09	.94	1.02	1.40	1.50	1.45	1.40	2.20	1.68	4.90	4.10	4.50	6.50	4.50	5.20
Fluorene	.23	.19	.21	.20	.20	.20	.15	.30	.22	1.10	.90	1.00	1.30	.70	1.00
Total Low Molecular Weight PAH			1.55						2.21						7.51
High Molecular Weight PAH															
Fluoranthene	1.09	1.30	1.20	.90	1.00	.95	.70	1.30	.98	2.80	2.60	2.70	3.30	3.10	3.00
Pyrene	1.12	1.21	1.16	.70	.80	.75	1.00	.50	.75	2.00	1.80	1.90	2.50	2.10	2.20
Chrysene + Benzo(a)anthracene	.90	.84	.87	.04	.05	.04	.40	.40	.28	1.00	.80	.90	1.70	1.70	1.40
Benzo(b)fluoranthene + Benzo(k)fluoranthene	1.01	1.16	1.08	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01
Benzo(a)pyrene	.27	.26	.26	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01
Benzo(ghi)perylene	.41	.48	.44	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01
Dibenzo(ah)anthracene	.18	.21	.20	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01
Indeno(1,2,3-cd)pyrene	.38	.17	.28	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01
Total High Molecular Weight PAH			5.49						2.01						6.60
Total PAH			7.04						4.22						14.11

* #1 = Mean of internal laboratory duplicates A & B

** X = Mean of replicates 1,2 & 3 (less than values set equal to detection limit to calculate means except when all replicates are below detection then less than values not included in PAH totals).

APPENDIX V (CONT'D) SEDIMENT POLYCYCLIC AROMATIC HYDROCARBON CONCENTRATIONS IN UG/G DRY WEIGHT - VANCOUVER HARBOUR 1985 - 1986

LABORATORY B:

Station/ Replicates	24						25A			35	39C	39D	39E	40	41
	1A	1B	#1*	#2	#3	X**	#1	#2	X	#1	#1	#1	#1	#1	#1
Low Molecular Weight PAH															
Naphthalene	.12	.11	.12	.08	.16	.12	.30	.30	.30	.03	.05	.13	.03	.24	<.01
Acenaphthylene	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	.08	.14	.23	.12	.14	.11
Acenaphthene	.04	.01	.02	<.01	.06	.03	.06	.08	.07	.03	.04	.04	.03	.12	.05
Anthracene + Phenanthrene	1.20	.70	.95	.50	1.90	1.12	1.80	2.20	2.00	.46	.65	.77	.59	1.07	.81
Fluorene	.13	.08	.10	.05	.20	.12	.20	.20	.20	.11	.14	.14	.11	.27	.18
Total Low Molecular Weight PAH						1.39			2.57	.71	1.02	1.31	.88	1.84	1.15
High Molecular Weight PAH															
Fluoranthene	.60	.40	.50	.40	1.40	.77	1.10	1.20	1.15	.40	.43	.45	.49	.50	.60
Pyrene	.40	.30	.35	.30	1.00	.55	.90	1.00	.95	.48	.57	.60	.59	1.19	.84
Chrysene + Benzo(a)anthracene	.07	.03	.05	.20	.30	.18	.20	.40	.30	.22	.29	.42	.29	.47	.51
Benzo(b)fluoranthene + Benzo(k)fluoranthene	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	.50	.40	.36	.41	.41	.71
Benzo(a)pyrene	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	.10	.10	.11	.08	.12	.16
Benzo(ghi)perylene	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	.21	.33	.31	.22	.18	.40
Dibenzo(ah)anthracene	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	.10	.10	.08	.08	.07	.15
Indeno(1,2,3-cd)pyrene	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	.22	.24	.22	.18	.15	.31
Total High Molecular Weight PAH						1.50			2.40	2.23	2.46	2.55	2.34	3.09	3.68
Total PAH						2.89			4.97	2.94	3.48	3.86	3.22	4.93	4.83

* #1 = Mean of internal laboratory duplicates A & B

** X = Mean of replicates 1,2 & 3 (less than values set equal to detection limit to calculate means except when all replicates are below detection then less than values not included in PAH totals).

APPENDIX C

VANCOUVER HARBOUR BENTHIC ENVIRONMENTAL QUALITY STUDIES

TRACE METALS AND ORGANIC COMPOUNDS IN SEDIMENTS - OCTOBER 1987

By

J. Boyd
B. Raymond
D. Goyette

OCTOBER 1989

REVIEW NOTICE

Data reports are prepared to make data available without full analysis or interpretation. This report has been reviewed by the Marine Programs Division, Environmental Protection, and approved for limited distribution. For further information please contact:

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TABLE OF CONTENTS

PAGE

REVIEW NOTICE i

TABLE OF CONTENTS ii

List of Figures iii

List of Tables iv

1.0 INTRODUCTION 1

2.0 MATERIALS AND METHODS 2

2.1 Study Area 2

2.2 Field Collection 2

2.3 Laboratory Analysis 2

2.3.1 Trace Metals 2

2.3.2 Organic Compounds 6

3.0 RESULTS 10

REFERENCES 24

ACKNOWLEDGEMENTS 25

APPENDIX I Vancouver Harbour Sampling Station Co-ordinates and Depths - October 1987 26

APPENDIX II Surface Sediment Trace Metal Concentrations in µg/g Dry Weight (October 1987) - Vancouver Harbour 28

APPENDIX III Descriptive Statistics of Surface Sediment Trace Metal Concentrations in µg/g Dry Weight (October 1987) - Vancouver Harbour 34

APPENDIX IV Trace Metal Concentrations (µg/g dry weight) in Standard Reference Materials (MESS-1) and Percentage Recovery by EP Laboratory for October 1987 Samples 43

APPENDIX V Surface Sediment Organic Compound Concentrations in µg/g Dry Weight (October 1987) - Vancouver Harbour 45

APPENDIX VI Descriptive Statistics of Surface Sediment Organic Compound Concentrations in µg/g Dry Weight (October 1987) - Vancouver Harbour 51

APPENDIX VII Sediment Polycyclic Aromatic Hydrocarbon (PAH) Concentrations in µg/g Dry Weight - Vancouver Harbour - October 1987 56

LIST OF FIGURES

PAGE

Figure 1 Vancouver Harbour Study Area and Reference Site, Loughborough Inlet 3

Figure 2 Sediment Sampling Stations in Vancouver Harbour (October 1987) - Inner and Outer Harbour 4

Figure 3 Sediment Sampling Stations in Vancouver Harbour (October 1987) - Port Moody Arm 5

Figure 4 Mean Surface Sediment Cadmium Concentrations in µg/g Dry Weight (October 1987) - Port Moody Arm 12

Figure 5 Mean Surface Sediment Chromium Concentrations in µg/g Dry Weight (October 1987) - Port Moody Arm 13

Figure 6 Mean Surface Sediment Copper Concentrations in µg/g Dry Weight (October 1987) - Port Moody Arm 14

Figure 7 Mean Surface Sediment Iron Concentrations in µg/g Dry Weight (October 1987) - Port Moody Arm 15

Figure 8 Mean Surface Sediment Mercury Concentrations in µg/g Dry Weight (October 1987) - Port Moody Arm 16

Figure 9 Mean Surface Sediment Nickel Concentrations in µg/g Dry Weight (October 1987) - Port Moody Arm 17

Figure 10 Mean Surface Sediment Lead Concentrations in µg/g Dry Weight (October 1987) - Port Moody Arm 18

Figure 11 Mean Surface Sediment Zinc Concentrations in µg/g Dry Weight (October 1987) - Port Moody Arm 19

Figure 12 Mean Surface Sediment Hydrocarbon Concentrations in µg/g Dry Weight (October 1987) - Port Moody Arm 20

Figure 13 Mean Surface Sediment Oils and Grease Concentrations in µg/g Dry Weight (October 1987) - Port Moody Arm 21

Figure 14 Mean Surface Sediment Polychlorinated Biphenyl (PCB) Concentrations in µg/g Dry Weight (October 1987) - Port Moody Arm 22

LIST OF TABLES

		PAGE
Table 1	Mean Concentrations of Selected Trace Metals from Vancouver Harbour Sediment - October 1987	11
Table 2	A Summary of Sediment Polycyclic Aromatic Hydrocarbon (PAH) Concentration (µg/g Dry Weight) in Vancouver Harbour - October 1987	23

1.0 INTRODUCTION

Environmental Protection (EP) began a monitoring program in May of 1985 to assess the benthic environmental quality of Vancouver Harbour. Contaminants entering the harbour from anthropogenic sources can be deposited in the sediment and potentially taken up by bottom-dwelling organisms. Sediment samples have been analyzed for trace metals, organic compounds, partical size, residues, and bacterial content (Thomas and Goyette, 1989a, 1989c, and 1989e, respectively). Tissues of benthic fish species and epibenthic invertebrates, potentially affected by contaminanted sediments, were analyzed for trace metals (Thomas and Goyette, 1989b) and polycyclic aromatic hydrocarbons (Thomas and Goyette, 1989d). In addition, flatfish species were examined for liver lesions and skin abnormalities (Goyette, et al., 1988).

The reports noted above document data collected in seven surveys conducted between May 1985 and September 1986. Due to the large size of the study area and limited sampling time per survey, only 7 of 73 stations were replicated during this period. The current report contains results of inorganic and organic concentrations in sediment samples collected in October of 1987, to supplement the earlier findings. A comparison of the current and previous results will be undertaken in a summary report currently in preparation.

2.0 MATERIALS AND METHODS

2.1 Study Area

The four hydrographic regions established during the May 1985 to September 1986 surveys of Vancouver Harbour were maintained for the October 1987 survey - the Outer Harbour, Inner Harbour, Central Harbour, and Port Moody Arm. Loughborough Inlet (LI), a coastal inlet removed from urban and industrial activity, was sampled as a reference location in July of 1987 (Figure 1). Study efforts were concentrated in Port Moody Arm including 17 previously established stations and 15 new stations. Only 2 stations in the Outer Harbour and 4 stations in the Inner Harbour were sampled during this survey. Station coordinates and depths are listed in Appendix I and the locations are mapped in Figures 2 and 3.

2.2 Field Collection

Sediment sampling was conducted from the research vessel, C.S.S. Vector, using a 0.1 m^2 stainless steel Smith-MacIntyre grab. Samples were collected in triplicate from each station using a stainless steel spoon to subsample the top 2 cm of the grab. Sediments for trace metal analysis were collected in kraft paper bags and enclosed in "whirlpaks". Samples for organic compound analysis were placed into heat-treated glass jars with aluminum foil lining the lids. All collections were immediately frozen for subsequent analysis.

2.3 Laboratory Analysis

2.3.1 Trace Metals

Sediment samples were analyzed for trace metals at the EP Laboratory in West Vancouver. The samples were dried at <40°C and passed through a 100-mesh stainless steel sieve (standard series). In a closed

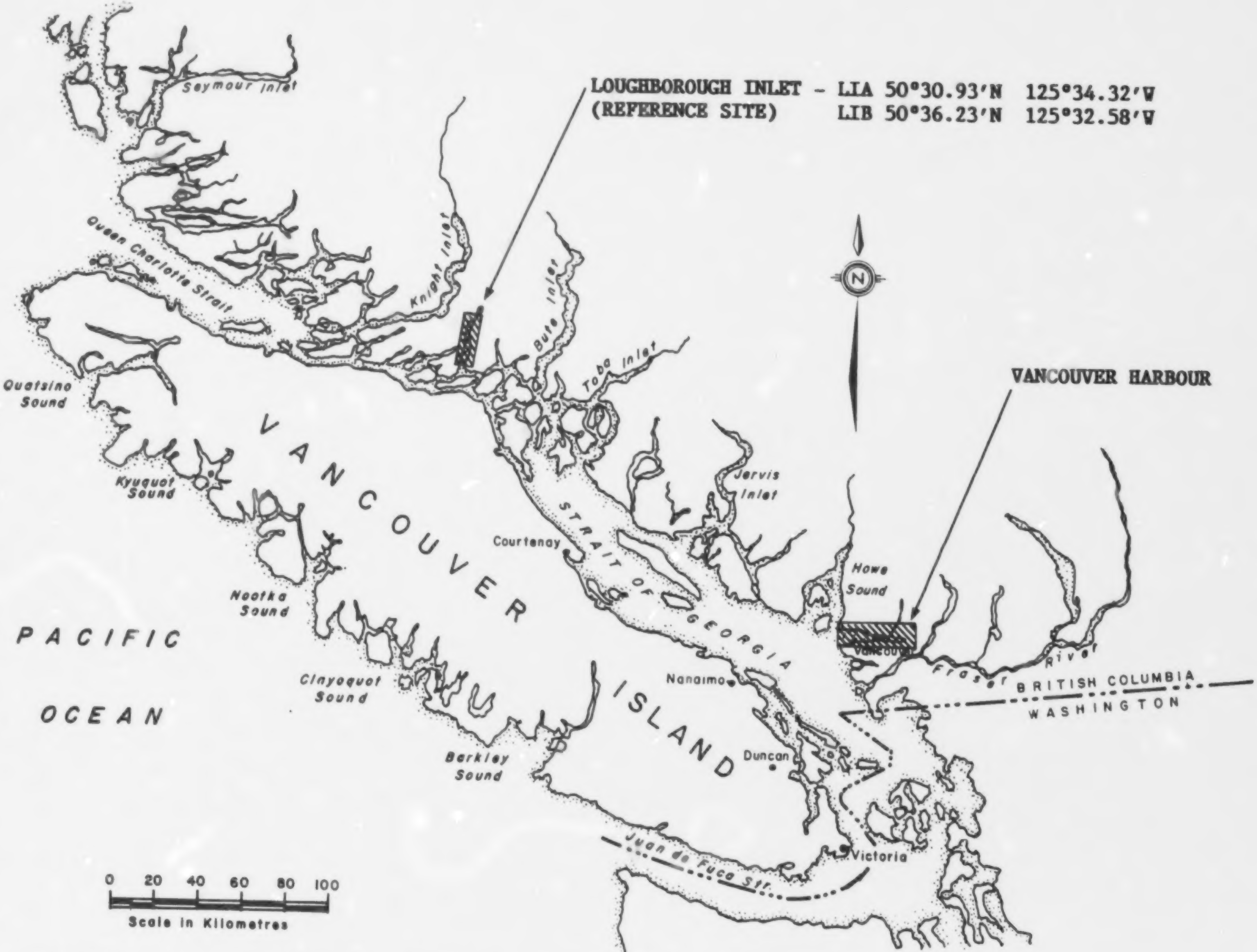
LOUGHBOROUGH INLET - LIA 50°30.93'N 125°34.32'W
(REFERENCE SITE) LIB 50°36.23'N 125°32.58'W
VANCOUVER HARBOUR
N
Seymour Inlet
Queen Charlotte Strait
Knight Inlet
Bute Inlet
Toba Inlet
Jervis Inlet
Howe Sound
Vancouv
Fraser River
BRITISH COLUMBIA
WASHINGTON
Quatsino Sound
Kyuquot Sound
Nootka Sound
Clayoquot Sound
Barkley Sound
VANCOUVER ISLAND
PACIFIC OCEAN
STRAIT OF GEORGIA
Courtenay
Nanaimo
Duncan
Victoria
Juan de Fuca Str.
0 20 40 60 80 100
Scale in Kilometres

FIGURE 1 VANCOUVER HARBOUR STUDY AREA AND REFERENCE SITE LOUGHBOROUGH INLET

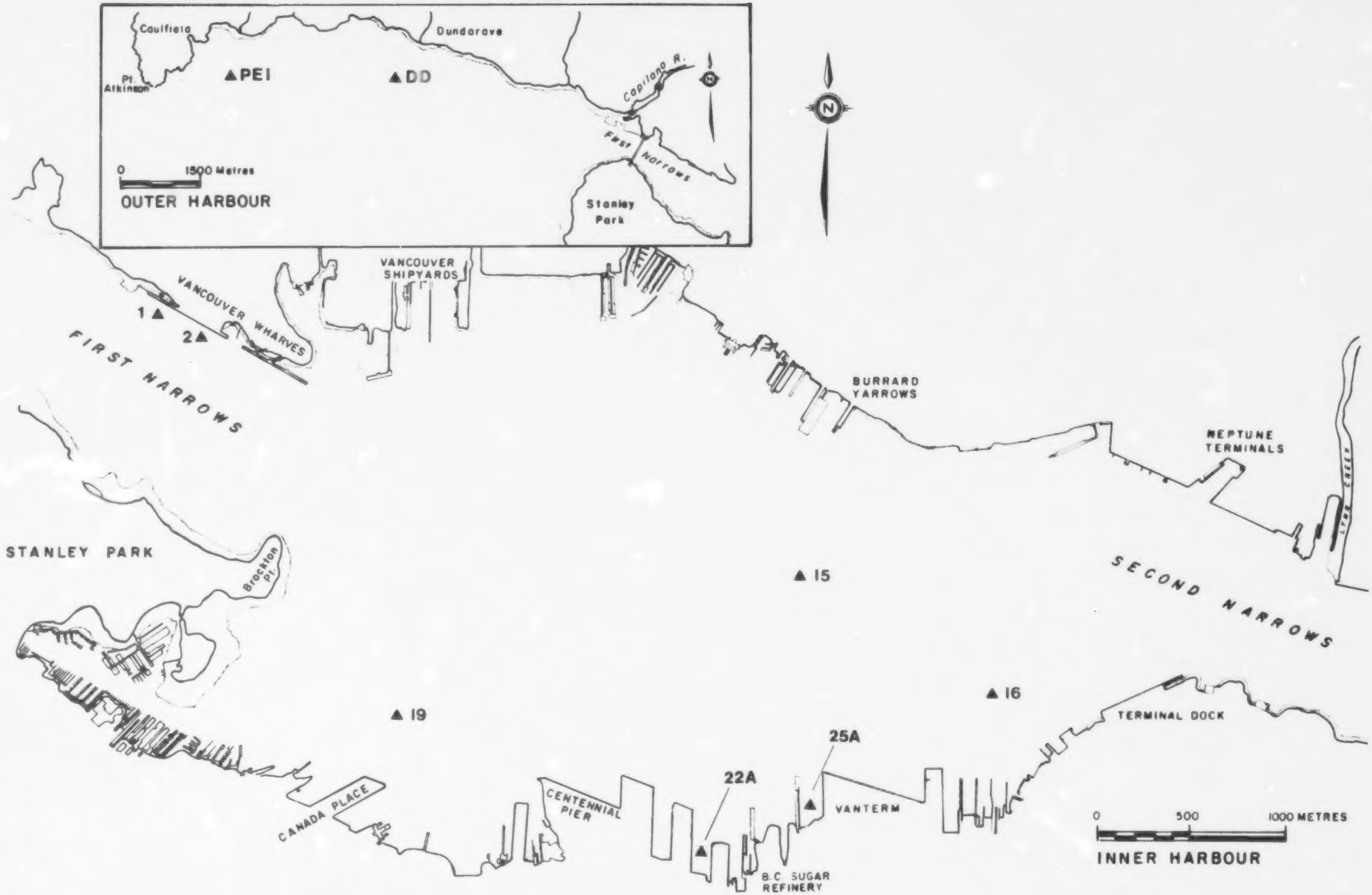
Caulfield
Pt. Atkinson
▲PEI
▲DD
Dundarave
Capilano R.
First Narrows
Stanley Park
0
1500 Metres
OUTER HARBOUR
N
VANCOUVER WHARVES
1▲
2▲
FIRST NARROWS
VANCOUVER SHIPYARDS
BURRARD YARROWS
NEPTUNE TERMINALS
LYNN CREEK
STANLEY PARK
Brockton Pt.
▲15
SECOND NARROWS
▲16
TERMINAL DOCK
▲19
25A
22A
VANTERM
CANADA PLACE
CENTENNIAL PIER
B.C. SUGAR REFINERY
0
500
1000 METRES
INNER HARBOUR

FIGURE 2 SEDIMENT SAMPLING STATIONS IN VANCOUVER HARBOUR (OCTOBER 1987) - INNER AND OUTER HARBOUR

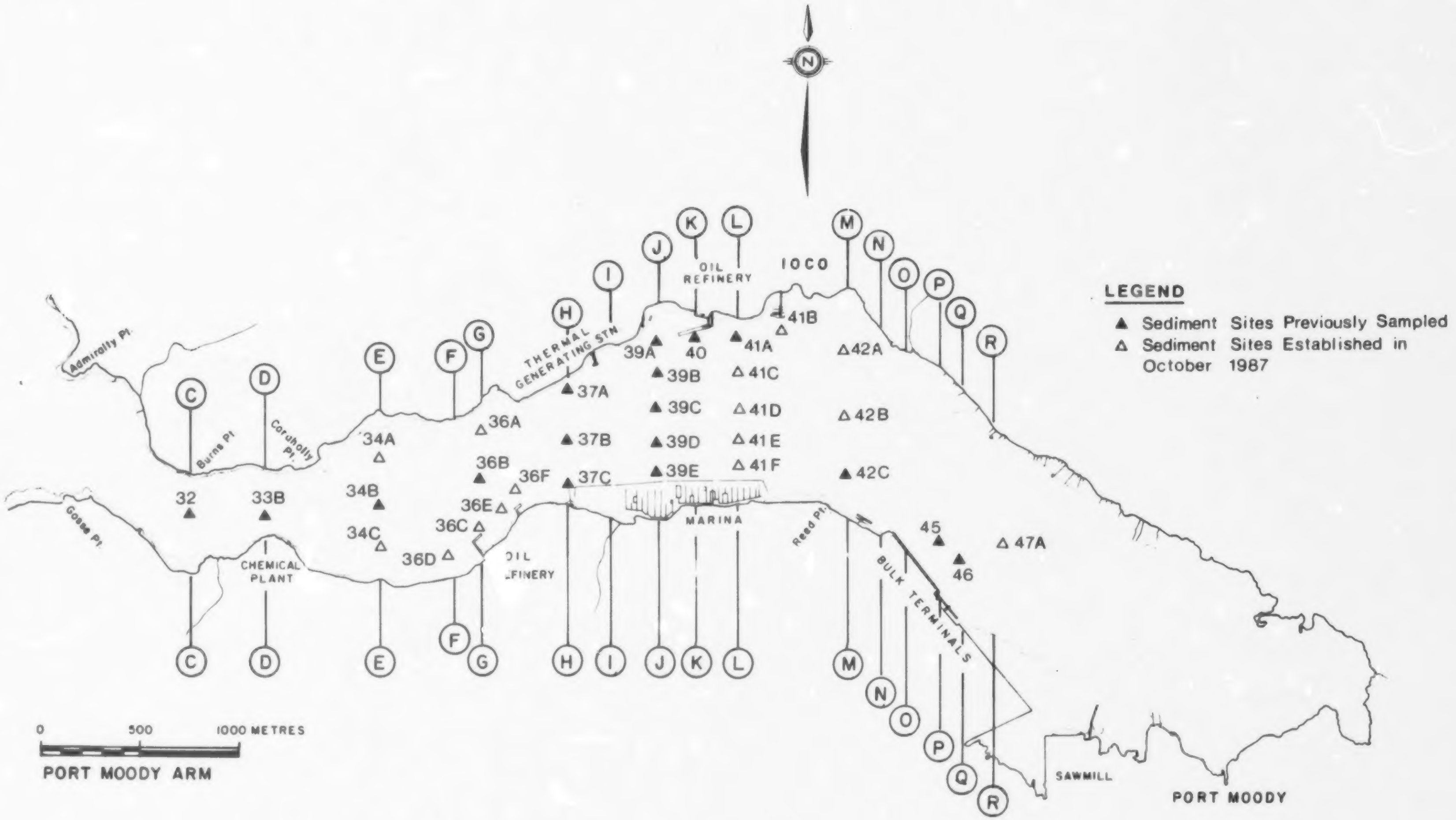
N
LEGEND
▲ Sediment Sites Previously Sampled
△ Sediment Sites Established in October 1987
Admiralty Pt.
Burns Pt.
Coruholly Pt.
Gosse Pt.
CHEMICAL PLANT
OIL REFINERY
THERMAL GENERATING STN
OIL REFINERY
IOCO
MARINA
Reed Pt.
BULK TERMINALS
SAWMILL
PORT MOODY
C
D
E
F
G
H
I
J
K
L
M
N
O
P
Q
R
32
33B
34A
34B
34C
36A
36B
36C
36D
36E
36F
37A
37B
37C
39A
39B
39C
39D
39E
40
41A
41B
41C
41D
41E
41F
42A
42B
42C
45
46
47A
0
500
1000 METRES
PORT MOODY ARM

FIGURE 3 SEDIMENT SAMPLING STATIONS IN VANCOUVER HARBOUR (OCTOBER 1987) - PORT MOODY ARM

vessel, the sediments were microwave digested in a 3:1 nitric-hydrochloric acid mixture (partial digestion), then analyzed for aluminum (Al), arsenic (As), barium (Ba), cadmium (Cd), chromium (Cr), copper (Cu), iron (Fe), mercury (Hg), magnesium (Mg), manganese (Mn), molybdenum (Mo), nickel (Ni), lead (Pb), tin (Sn), strontium (Sr), vanadium (V), and zinc (Zn).

Most trace metal levels were determined using a "Jarrell Ash 975" inductively coupled plasma optical emission spectrophotometer (ICP-AES). Low-level cadmium concentrations were obtained using a "Varian 1475" graphite furnace (GTA95) atomic absorption spectrophotometer (GF-AAS). Mercury levels were measured by cold vapour atomic absorption (CVAA) using a "Pharmacia" LCD mercury monitor with a 30 cm absorption cell. Further documentation of the analytical procedures is available from the EP Laboratory.

To evaluate the accuracy of metal detection methodologies, standard marine sediment reference material (MESS-1) from the National Research Council of Canada (NRCC) was analyzed in conjunction with the Vancouver Harbour samples. Certain trace metal values have been certified by NRCC when derived using at least two independent analytical techniques. Comparability was determined as the percent recovery by the EP lab analytical technique (i.e. the mean EP Laboratory value divided by the NRCC mean and multiplied by 100.)

2.3.2 Organic Compounds

Procedures for oils and grease, hydrocarbons, polychlorinated biphenyls (PCB), chlorophenols (penta, tetra, tri) and polcyclic aromatic hydrocarbons (PAH) analyses are summarized below. All parameters were quantified in µg/g dry weight. Detailed descriptions of the methodologies can be obtained from the EP Laboratory.

Oils and Grease

The sediments were air-dried overnight and a weighed portion was placed in a centrifuge tube with anhydrous Na_2SO_4, concentrated sulphuric acid, and Freon 113. The tube was sealed and mixed on a wrist-action shaker for 90 minutes then centrifuged for 10 minutes. The oils and grease were quantified on an infrared spectrophotometer (5 cm UV cell) as the difference between the absorbance of the freon extract at 4000 (baseline) and 2935 cm-1. Quantities were reported in µg/g dry weight "standard oil" equivalent. Recovery of a "standard oil" (15 ml hexadecane, 15 ml iso-octane, and 10 ml chlorobenzene) spike at the 0.25 mg/l level gave 92% recovery with a mean of 0.23 mg/l (S.D.=0.04) over 8 replicates.

Hydrocarbons

The freon extract from the oils and grease analysis was mixed with silica gel, shaken for 30 minutes, centrifuged for 10 minutes, and filtered through a small funnel with GF/C paper and a small amount of Na_2SO_4. The resulting extract was measured by infrared spectrophotometry as for oils and grease to determine hydrocarbon values. The precision and accuracy of this technique is the same as that reported for oils and grease.

Polychlorinated Biphenyls (PCB)

The sample was air-dried, weighed, and transferred to a centrifuge tube containing acetone. The sample was agitated for 2 hours and filtered though GC/F paper. The solute was transferred to a separatory funnel and extracted with hexane after adding 2% NaCl. The extract was concentrated to about 5 ml on a rotary evaporator and quantitatively transferred to a 2% florisil column where it was eluted. The extract was concentrated again to 5 ml, then treated successively with activated copper, sulphuric acid, and mercury to remove interferences. A known amount of the concentrated sample was injected into a packed column gas chromatograph with an electron capture detector. PCB Aroclors were identified by the peak distribution pattern and a comparison of the retention times. Quantitative analysis was based on the injection of the appropriate standard and summation of areas under the most significant resolved GC peaks.

The minimum detectable concentration of Aroclor 1260 is 0.01 µg/l in sediment. At the EP Laboratory, recovery studies of Aroclor 1254 in sediments gave an average recovery of 89%. Coefficients of variation ranged from 1.4% to 12.7%. The texture of the sediment had a pronounced effect on the recoveries, the coarser the sediment the better the recovery.

Chlorophenols

Chlorophenols were also analyzed using a packed column gas chromatograph with an electron capture detector. The procedure is the same as described for PCB except for an added step converting the chlorophenols to their anisole derivatives using diazomethane.

The minimum detectable concentrations of trichlorophenols, tetrachlorophenols, and pentachlorophenol were 0.0005 µg/g, 0.0002 µg/g, and 0.0001 µg/g, respectively. At the EP Laboratory, average recovery values of pentachlorophenol and 2,3,4,6-tetrachlorophenol from fortified wastewater were 96% and 90% with coefficients of variation of 2.4% and 4.3%, respectively. Precision averaged 30.7% and 28.0% standard deviation for pentachlorophenol and 2,3,4,6-tetrachlorophenol for duplicate analyses of sediment samples over a 21 month period.

Polycyclic Aromatic Hydrocarbons (PAH)

Sediment samples were dried at room temperature and passed through a #10 (2mm) seive. Approximately 15 g of sample was transferred to an extraction thimble, spiked with 3 PAH surrogate compounds (napthalene-d_8, acenaphthene-d_{10}, and 2-flurobiphenyl) to monitor extraction/recovery efficiency and then soxhlet extracted with dichloromethane for 16 hr. The dichloromethane extract was rotary evaporated to near dryness and ultimately transferred to a partially deactivated neutral alumina column topped with anhydrous sodium sulphate. Three fractions were collected by eluting the column with pentane (Fraction 1), benzene (Fraction 2) and dichloromethane (Fraction 3). Fraction 2, the PAH fraction, was evaporated to near dryness, redissolved in hexane and treated with mercury for sulphur removal. Anthracene-d_{10} was added as an internal standard and the sample analyzed on a GC/MS system using MID mode (three selected ions) for confirmation and quantification. In addition to spiking samples with surrogates, method blanks and duplicate sediments were analyzed as part of the quality control procedures.

3.0 RESULTS

Mean cadmium, chromium, copper, iron, mercury, nickel, lead, and zinc concentrations in Vancouver Harbour sediment samples are presented in Table 1. Distributions of those metals have been plotted for Port Moody Arm, the main area sampled (Figures 4 - 11), for relative comparison. The raw data and descriptive statistics for all inorganics measured can be found in Appendix II and III, respectively. The trace metal reference sediment results (MESS-1) are tabled in Appendix IV. Cadmium, copper, iron, mercury, molybdenum, nickel, lead, and zinc were recovered at a rate $\geq$70%. Arsenic and strontium values were below detection, therefore, a recovery value was not calculated.

Distribution of hydrocarbons, oils and grease, and polychlorinated biphenyls (PCB) in Port Moody Arm sediment is illustrated in Figures 12 to 14. Compared with earlier results (Thomas and Goyette, 1989c), current PCB methods permit the identification of different isomers. Three Aroclors (1242, 1254, and 1260) were detected in Vancouver Harbour samples, then the values summed to calculate total PCB. The raw data and descriptive statistics for organic compounds excluding PAH, are reported in Appendix V and VI, respectively.

The PAH compounds measured in the Vancouver Harbour sediment samples included 6 low molecular weight PAH and 10 high molecular weight PAH. Mean concentrations for individual compounds, low molecular weight, high molecular weight, and total PAH values are summarized in Table 2. Recovery rates for the 3 surrogate PAH compounds added to each samples were as follows:

COMPOUND	N	MEAN RECOVERY	STANDARD DEVIATION
Naphthalene-d_8	53	72	20
Acenaphthene-d_{10}	53	88	18
2-Flurobiphenyl	53	87	20

The results of individual samples including quality control duplicates, have been provided in Appendix VII.

TABLE 1 MEAN CONCENTRATIONS OF SELECTED TRACE METALS FROM VANCOUVER HARBOUR SEDIMENT - OCTOBER 1987

			Concentration µg/g dry weight							
AREA	STN	N	Cd	Cr	Cu	Fe(%)	Hg	Ni	Pb	Zn
OUTER HARBOUR	PEI	3	0.24	51.7	180	3.8	0.150	40	40	142
	DD	3	0.38	48.9	298	3.7	0.173	37	53	157
INNER HARBOUR	1	1	2.37	48.5	9760	4.3	0.173	64	2060	520
	2	3	2.77	50.7	6547	4.3	0.157	119	1023	518
	22A	3	1.74	39.4	1240	3.3	0.245	27	116	355
	25A	3	2.01	53.6	444	3.2	2.853	33	295	332
PORT MOODY ARM	32	3	0.80	50.6	223	3.7	0.313	27	78	192
	33B	3	1.20	53.5	231	4.4	0.318	26	79	214
	34A	3	0.66	65.6	206	3.8	0.376	27	86	196
	34B	3	0.79	60.9	207	3.9	0.353	28	87	200
	34C	3	10.22	58.8	210	3.7	0.366	28	88	199
	36A	3	0.91	72.7	188	3.7	0.362	29	96	209
	36B	3	0.96	63.8	238	3.6	0.317	28	95	200
	36C	3	4.89	57.0	162	3.8	0.293	25	77	218
	36D	3	0.97	62.2	202	3.8	0.361	28	92	203
	36E	3	0.96	60.7	180	4.2	0.365	27	87	206
	36F	3	0.94	58.5	173	3.8	0.346	25	89	219
	37A	3	1.27	74.5	161	3.6	0.389	29	109	210
	37B	3	1.13	58.6	148	3.9	0.440	26	93	203
	37C	3	1.27	59.4	158	3.7	0.375	25	91	212
	39A	3	1.77	80.1	152	3.7	0.434	32	134	222
	39B	3	1.74	74.9	133	3.5	0.383	29	109	219
	39C	3	1.40	79.1	136	3.6	0.358	30	93	204
	39D	3	1.30	61.9	142	3.7	0.368	27	92	210
	39E	3	1.40	63.1	144	3.6	0.370	26	94	216
	40	3	3.10	96.1	134	3.7	0.475	32	298	317
	41A	3	1.97	128.0	144	3.7	0.331	27	120	246
	41B	3	5.80	111.7	135	3.6	0.293	27	110	244
	41C	3	1.66	78.2	131	3.6	0.283	27	86	209
	41D	3	1.84	69.7	146	3.6	0.362	28	83	202
	41E	3	1.69	67.5	130	3.6	0.319	27	80	198
	41F	3	1.69	62.9	125	3.6	0.304	26	78	201
	42A	3	2.49	86.4	116	3.4	0.274	24	96	226
	42B	3	4.31	67.6	105	3.5	0.232	25	62	194
	42C	3	1.95	52.7	73	3.7	0.147	29	26	138
	45	3	1.65	44.7	62	3.2	0.109	28	19	126
	46	3	2.87	64.4	107	3.6	0.213	29	64	250
	47A	3	3.08	67.5	114	3.7	0.198	30	69	221
Loughborough	LI-A	3	0.56	33.8	62	3.4	0.123	23	22	127
Inlet*	LI-B	3	0.31	38.4	65	3.0	0.120	21	22	103

* Reference site sampled in July of 1987 (see Figure 1)

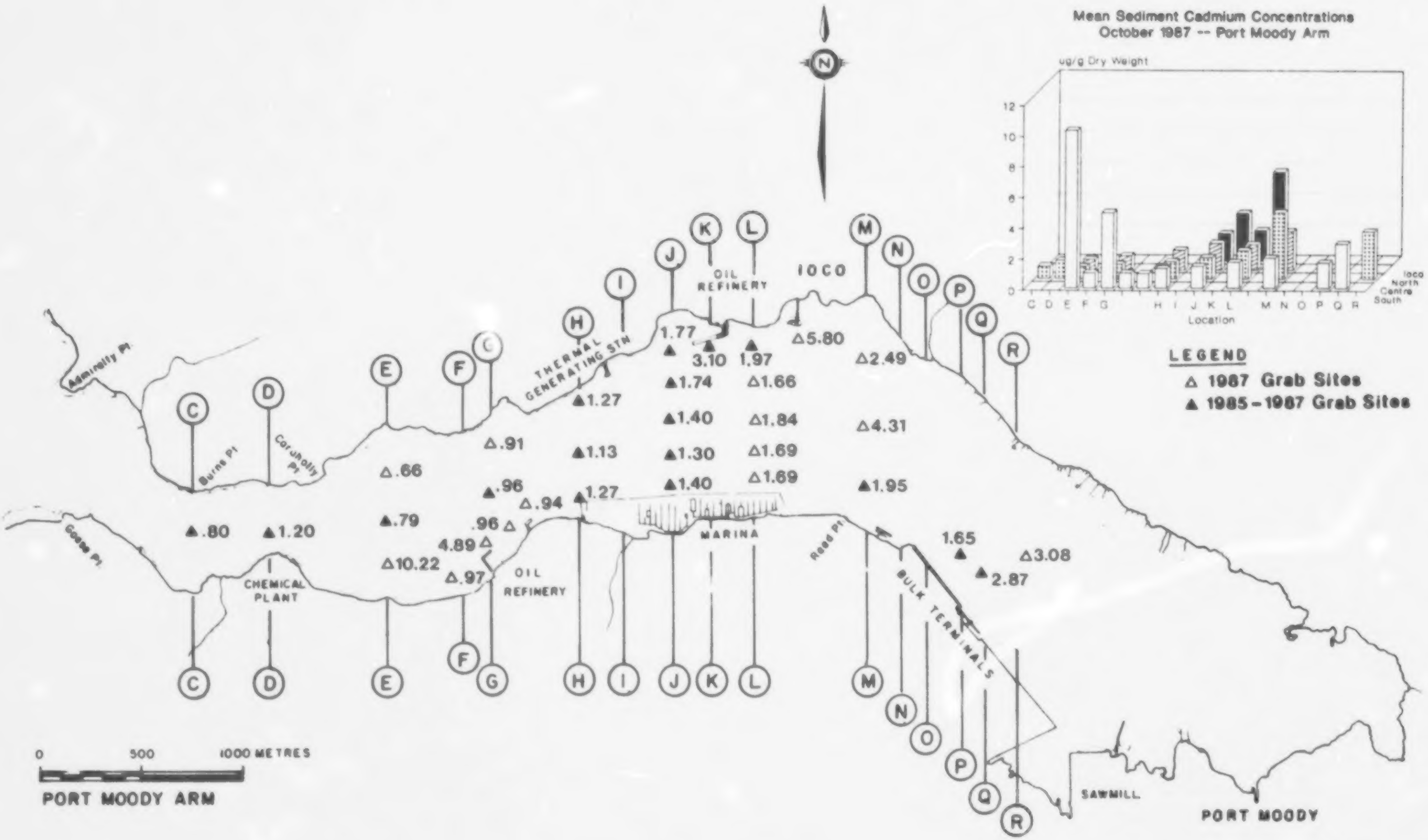
Mean Sediment Cadmium Concentrations
October 1987 -- Port Moody Arm
ug/g Dry Weight
12
10
8
6
4
2
0
C D E F G H I J K L M N O P Q R
Location
Ioco
North
Centre
South
LEGEND
△ 1987 Grab Sites
▲ 1985 - 1987 Grab Sites
N
Admiralty Pt.
Burns Pt
Carraholly Pt
Gosse Pt.
CHEMICAL PLANT
THERMAL GENERATING STN
OIL REFINERY
IOCO
MARINA
Reed Pt
BULK TERMINALS
SAWMILL
PORT MOODY
C
D
E
F
G
H
I
J
K
L
M
N
O
P
Q
R
▲.80
▲1.20
△.66
▲.79
△10.22
△.91
▲.96
△.94
.96 △
4.89 △
△.97
▲1.27
▲1.13
▲1.27
1.77 ▲
3.10 ▲
1.97 ▲
▲1.74
▲1.40
▲1.30
▲1.40
△1.66
△1.84
△1.69
△1.69
△5.80
△2.49
△4.31
▲1.95
1.65 ▲
▲2.87
△3.08
0
500
1000 METRES
PORT MOODY ARM

FIGURE 4 MEAN SURFACE SEDIMENT CADMIUM CONCENTRATIONS IN UG/G DRY WEIGHT (OCTOBER 1987) - PORT MOODY ARM

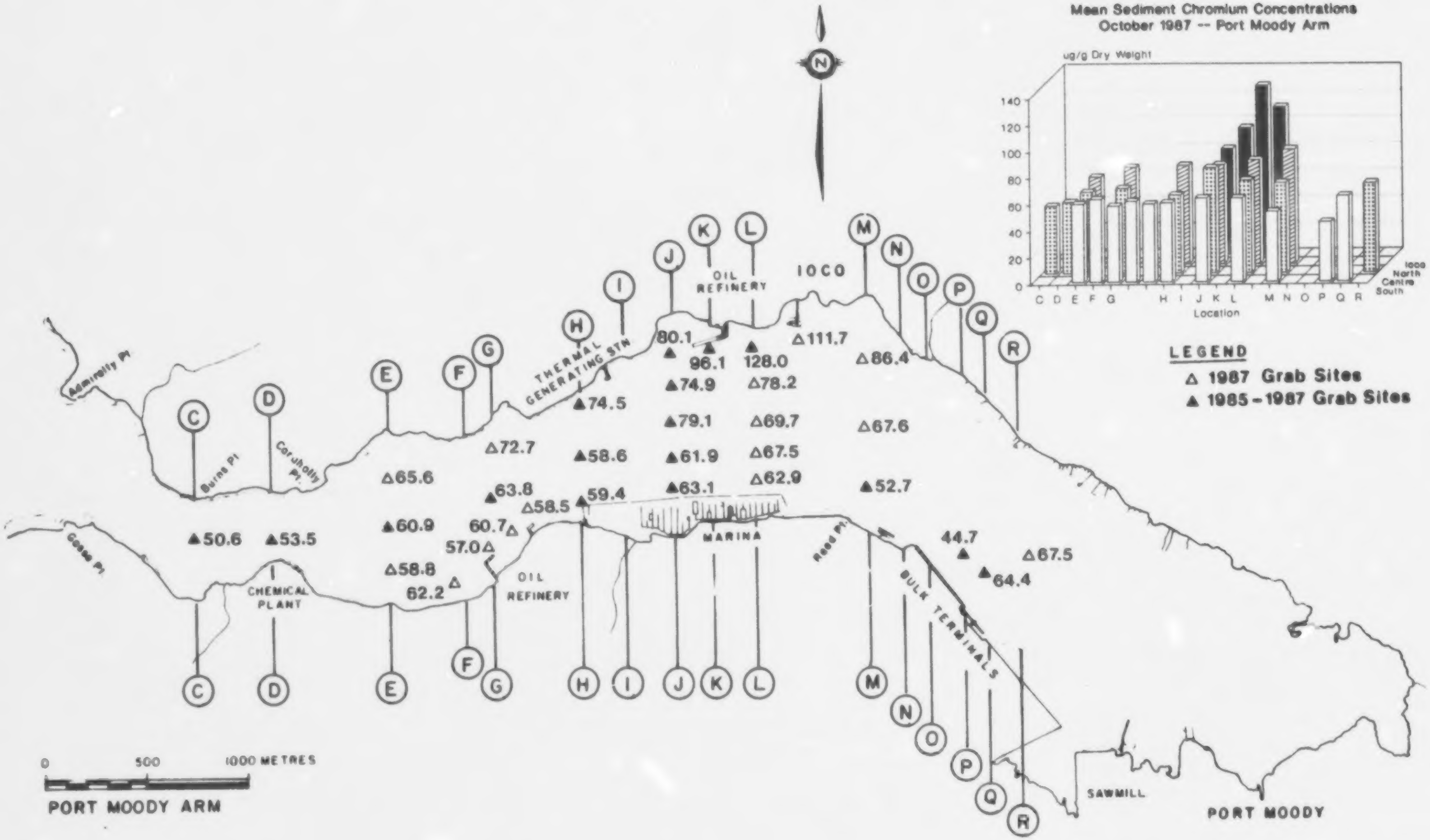
Mean Sediment Chromium Concentrations
October 1987 -- Port Moody Arm
ug/g Dry Weight
140
120
100
80
60
40
20
0
C D E F G H I J K L M N O P Q R
Location
Ioco
North
Centre
South
LEGEND
△ 1987 Grab Sites
▲ 1985-1987 Grab Sites
N
Admiralty Pt
Burns Pt
Cor-holly Pt.
Gosse Pt
CHEMICAL PLANT
THERMAL GENERATING STN
OIL REFINERY
IOCO
OIL REFINERY
MARINA
Reed Pt.
BULK TERMINALS
SAWMILL
PORT MOODY
C
D
E
F
G
H
I
J
K
L
M
N
O
P
Q
R
▲50.6
▲53.5
△65.6
▲60.9
△58.8
62.2 △
△72.7
▲63.8
60.7△
57.0△
△58.5
▲74.5
▲58.6
▲59.4
80.1 ▲
▲ 96.1
▲74.9
▲79.1
▲61.9
▲63.1
▲ 128.0
△78.2
△69.7
△67.5
△62.9
△111.7
△86.4
△67.6
▲52.7
44.7 ▲
▲64.4
△67.5
0
500
1000 METRES
PORT MOODY ARM

FIGURE 5 MEAN SURFACE SEDIMENT CHROMIUM CONCENTRATIONS IN UG/G DRY WEIGHT (OCTOBER 1987) - PORT MOODY ARM

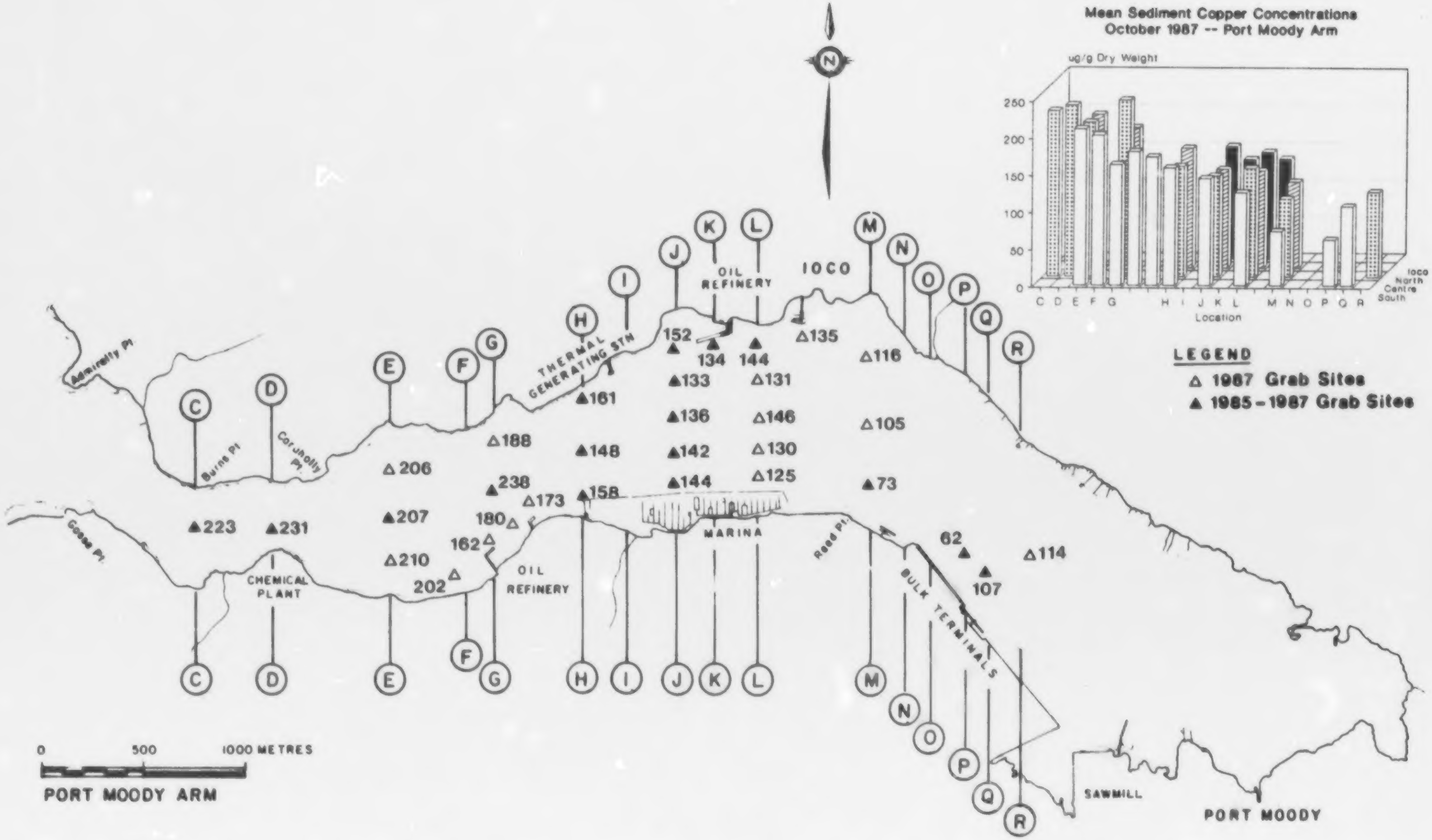
Mean Sediment Copper Concentrations
October 1987 -- Port Moody Arm
ug/g Dry Weight
250
200
150
100
50
0
C D E F G H I J K L M N O P Q R
Location
Ioco
North
Centre
South
LEGEND
△ 1987 Grab Sites
▲ 1985-1987 Grab Sites
N
C
D
E
F
G
H
I
J
K
L
M
N
O
P
Q
R
Admiralty Pt
Burns Pt
Carraholly Pt
Gosse Pt
CHEMICAL PLANT
THERMAL GENERATING STN
OIL REFINERY
IOCO
MARINA
Reed Pt
BULK TERMINALS
SAWMILL
PORT MOODY
▲223
▲231
△206
▲207
△210
202△
△188
▲238
180△
162△
△173
▲161
▲148
▲158
152▲
▲134
▲133
▲136
▲142
▲144
▲144
△131
△146
△130
△125
△135
△116
△105
▲73
62▲
▲107
△114
0
500
1000 METRES
PORT MOODY ARM

FIGURE 6 MEAN SURFACE SEDIMENT COPPER CONCENTRATIONS IN UG/G DRY WEIGHT (OCTOBER 1987) - PORT MOODY ARM

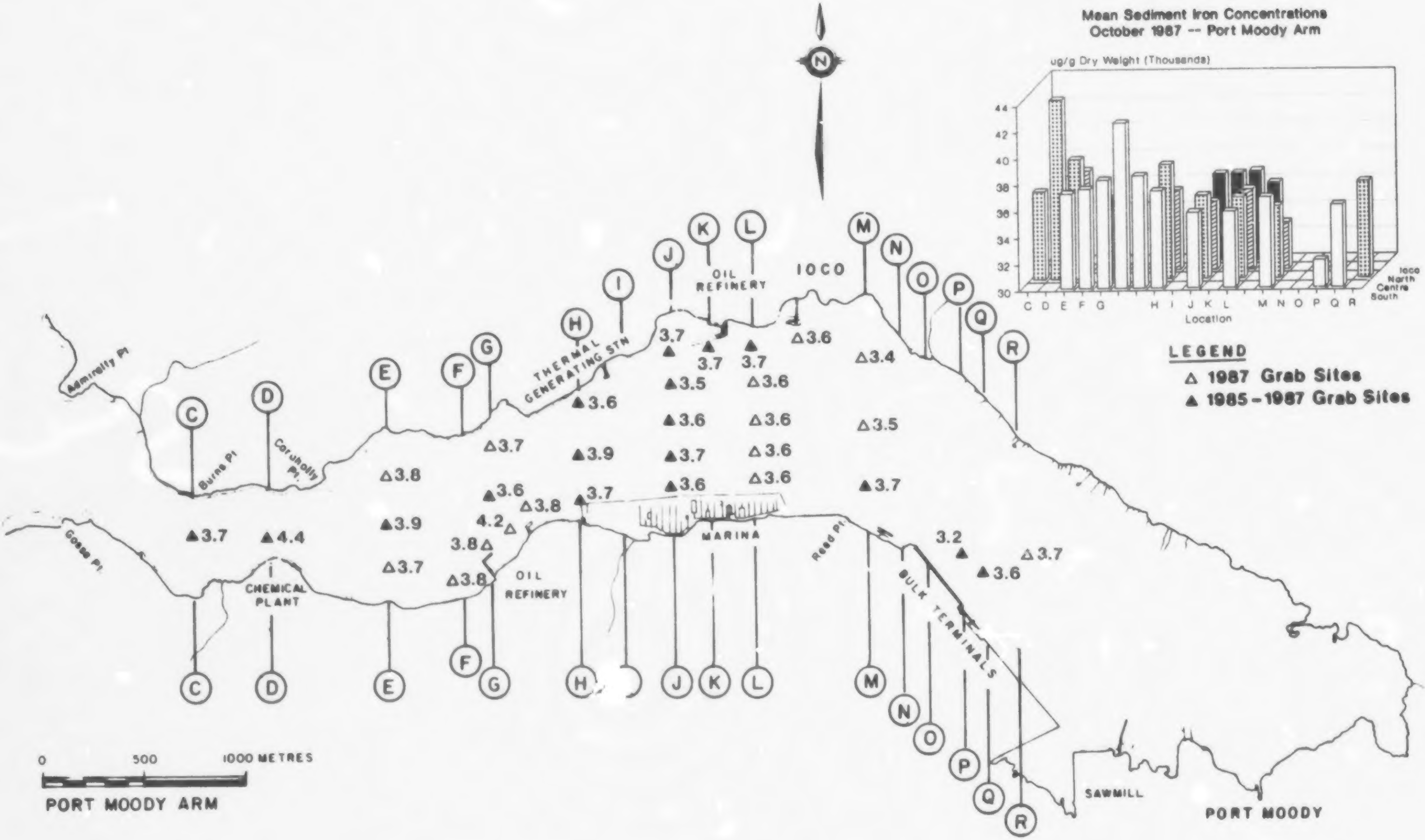
Mean Sediment Iron Concentrations
October 1987 -- Port Moody Arm
ug/g Dry Weight (Thousands)
44
42
40
38
36
34
32
30
C D E F G H I J K L M N O P Q R
Location
Ioco
North
Centre
South
LEGEND
△ 1987 Grab Sites
▲ 1985-1987 Grab Sites
N
Admiralty Pt
Burns Pt
Cozy Jolly Pt
Gosse Pt
CHEMICAL PLANT
THERMAL GENERATING STN
OIL REFINERY
IOCO
OIL REFINERY
MARINA
Reed Pt
BULK TERMINALS
SAWMILL
PORT MOODY
C
D
E
F
G
H
I
J
K
L
M
N
O
P
Q
R
▲3.7
▲4.4
△3.8
▲3.9
△3.7
△3.7
▲3.6
4.2△
3.8△
△3.8
△3.8
▲3.6
▲3.9
▲3.7
3.7▲
▲3.5
▲3.6
▲3.7
▲3.6
3.7▲
3.7▲
△3.6
△3.6
△3.6
△3.6
△3.6
△3.4
△3.5
▲3.7
3.2▲
▲3.6
△3.7
0
500
1000 METRES
PORT MOODY ARM

FIGURE 7 MEAN SURFACE SEDIMENT IRON CONCENTRATIONS IN PER CENT DRY WEIGHT (OCTOBER 1987) - PORT MOODY ARM

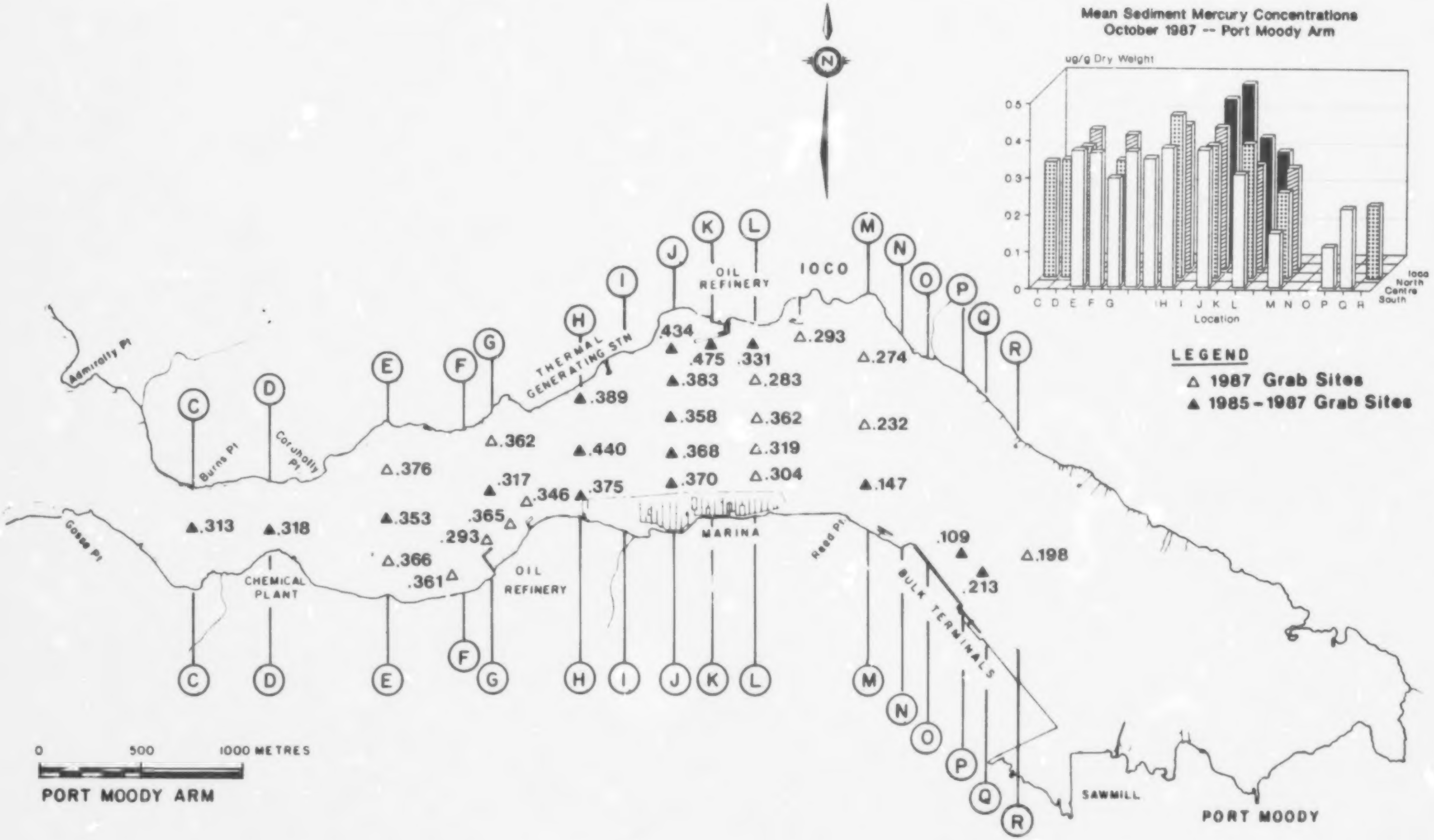
Mean Sediment Mercury Concentrations
October 1987 -- Port Moody Arm
ug/g Dry Weight
0.5
0.4
0.3
0.2
0.1
0
C D E F G H I J K L M N O P Q R
Location
Ioco
North
Centre
South
LEGEND
△ 1987 Grab Sites
▲ 1985-1987 Grab Sites
Admiralty Pt
Burns Pt
Caruholly Pt
Gosse Pt
CHEMICAL PLANT
THERMAL GENERATING STN
OIL REFINERY
IOCO
OIL REFINERY
MARINA
Reed Pt
BULK TERMINALS
SAWMILL
PORT MOODY
C
D
E
F
G
H
I
J
K
L
M
N
O
P
Q
R
.313
.318
.376
.353
.366
.361
.362
.317
.365
.293
.346
.389
.440
.375
.434
.475
.383
.358
.368
.370
.331
.283
.362
.319
.304
.293
.274
.232
.147
.109
.213
.198
0
500
1000 METRES
PORT MOODY ARM

FIGURE 8 MEAN SURFACE SEDIMENT MERCURY CONCENTRATIONS IN UG/G DRY WEIGHT (OCTOBER 1987) - PORT MOODY ARM

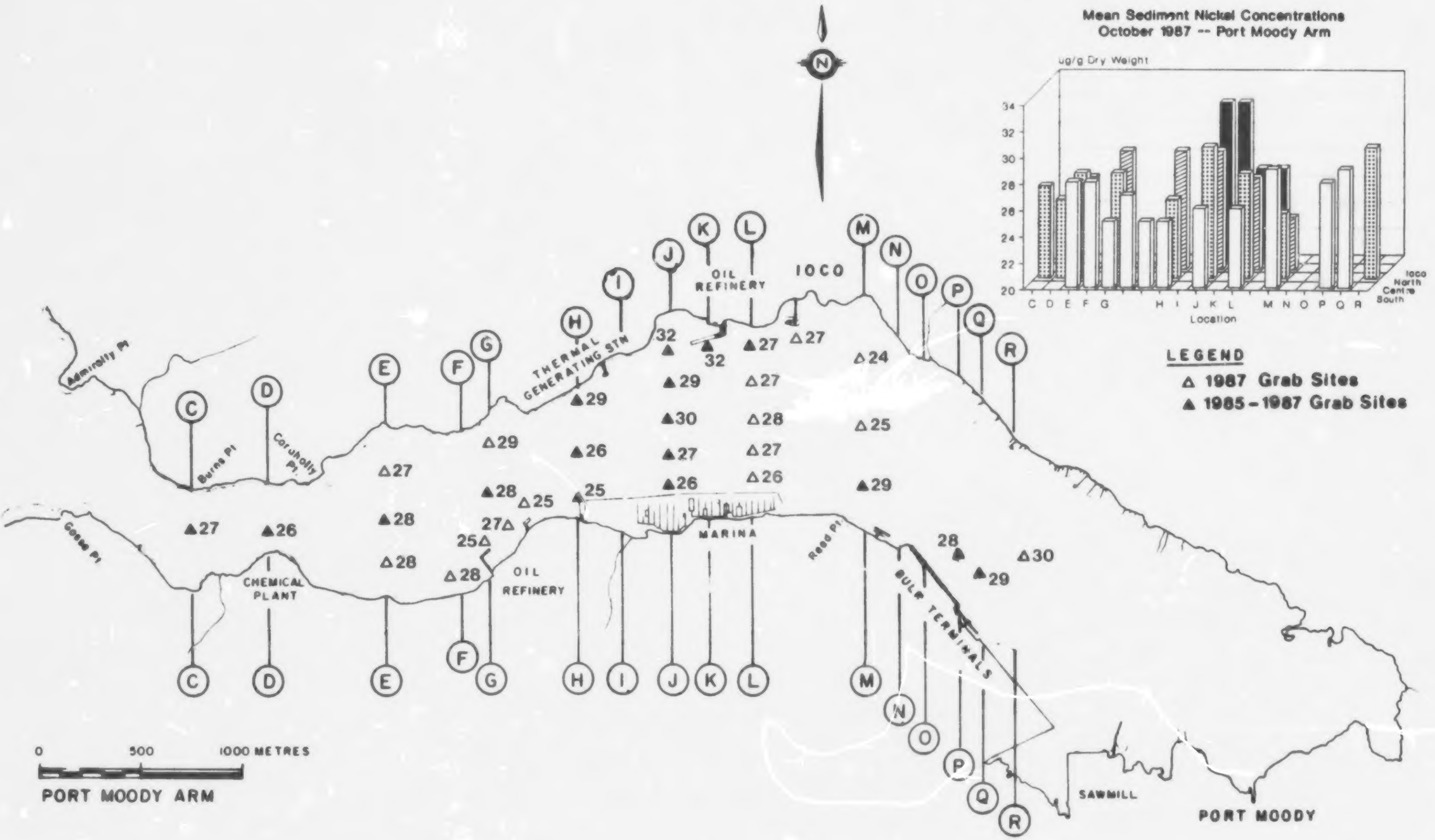
Mean Sediment Nickel Concentrations
October 1987 -- Port Moody Arm
ug/g Dry Weight
34
32
30
28
26
24
22
20
C D E F G H I J K L M N O P Q R
Location
Ioco
North
Centre
South
LEGEND
△ 1987 Grab Sites
▲ 1985-1987 Grab Sites
N
Admiralty Pt
Burns Pt
Caruholly Pt
Goose Pt
CHEMICAL PLANT
OIL REFINERY
THERMAL GENERATING STN
IOCO
MARINA
Reed Pt
BULK TERMINALS
SAWMILL
PORT MOODY
C
D
E
F
G
H
I
J
K
L
M
N
O
P
Q
R
▲27
▲26
△27
▲28
△28
△29
▲28
△25
27△
25△
△28
▲29
▲26
▲25
32▲
▲32
▲29
▲30
▲27
▲26
▲27
△27
△27
△28
△27
△26
△24
△25
▲29
28▲
▲29
△30
0
500
1000 METRES
PORT MOODY ARM

FIGURE 9 MEAN SURFACE SEDIMENT NICKEL CONCENTRATIONS IN UG/G DRY WEIGHT (OCTOBER 1987) - PORT MOODY ARM

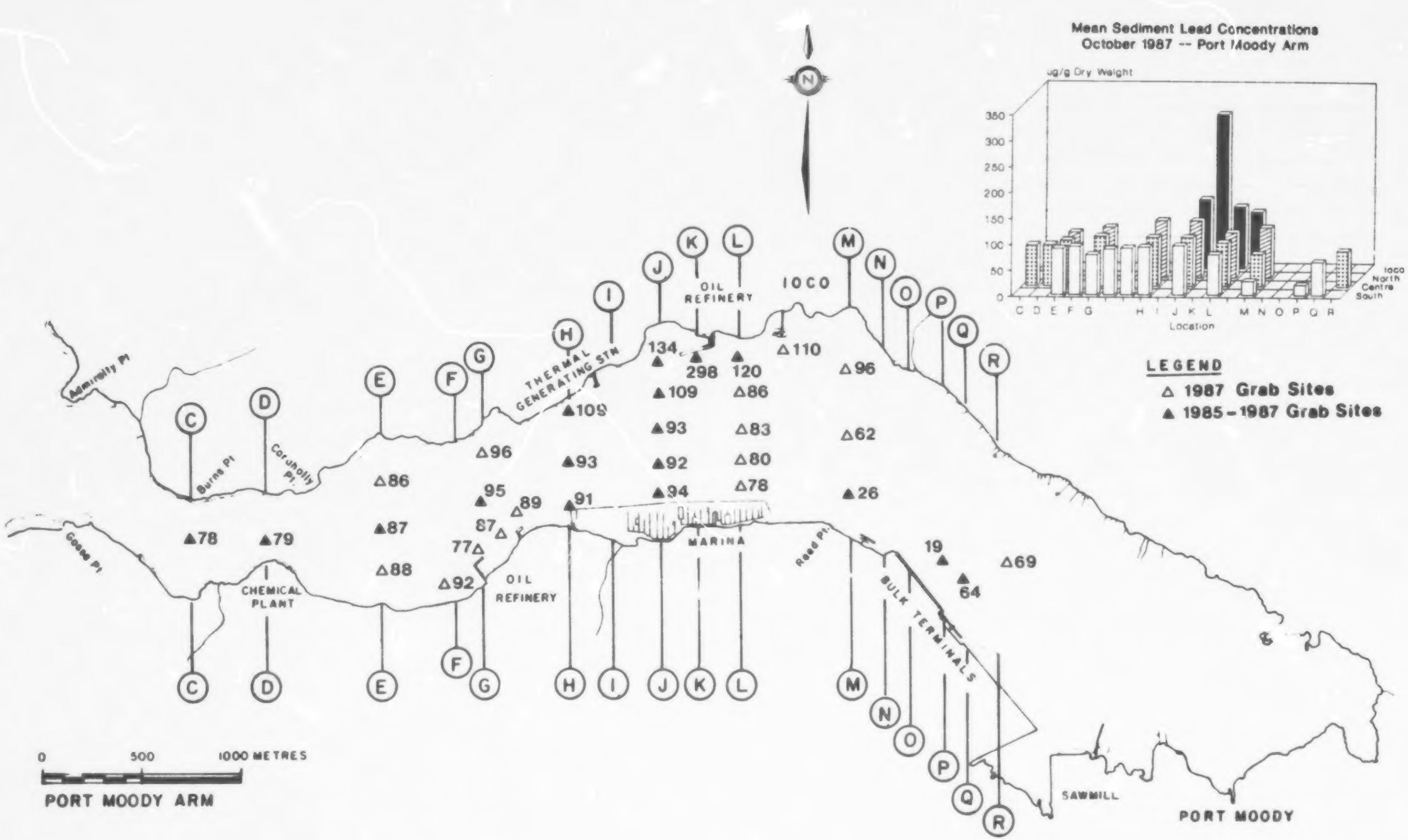
Mean Sediment Lead Concentrations
October 1987 -- Port Moody Arm
ug/g Dry Weight
350
300
250
200
150
100
50
0
C D E F G H I J K L M N O P Q R
Location
Ioco
North
Centre
South
LEGEND
△ 1987 Grab Sites
▲ 1985-1987 Grab Sites
N
Admiralty Pt
Burns Pt
Carraholly Pt.
Goose Pt
CHEMICAL PLANT
OIL REFINERY
THERMAL GENERATING STN
IOCO
MARINA
Reed Pt.
BULK TERMINALS
SAWMILL
PORT MOODY
C
D
E
F
G
H
I
J
K
L
M
N
O
P
Q
R
▲78
▲79
△86
▲87
△88
△96
▲95
△89
87△
77△
△92
▲109
▲93
▲91
134▲
▲109
▲93
▲92
▲94
▲298
▲120
△86
△83
△80
△78
△110
△96
△62
▲26
19▲
▲64
△69
0
500
1000 METRES
PORT MOODY ARM

FIGURE 10 MEAN SURFACE SEDIMENT LEAD CONCENTRATIONS IN UG/G DRY WEIGHT (OCTOBER 1987) - PORT MOODY ARM

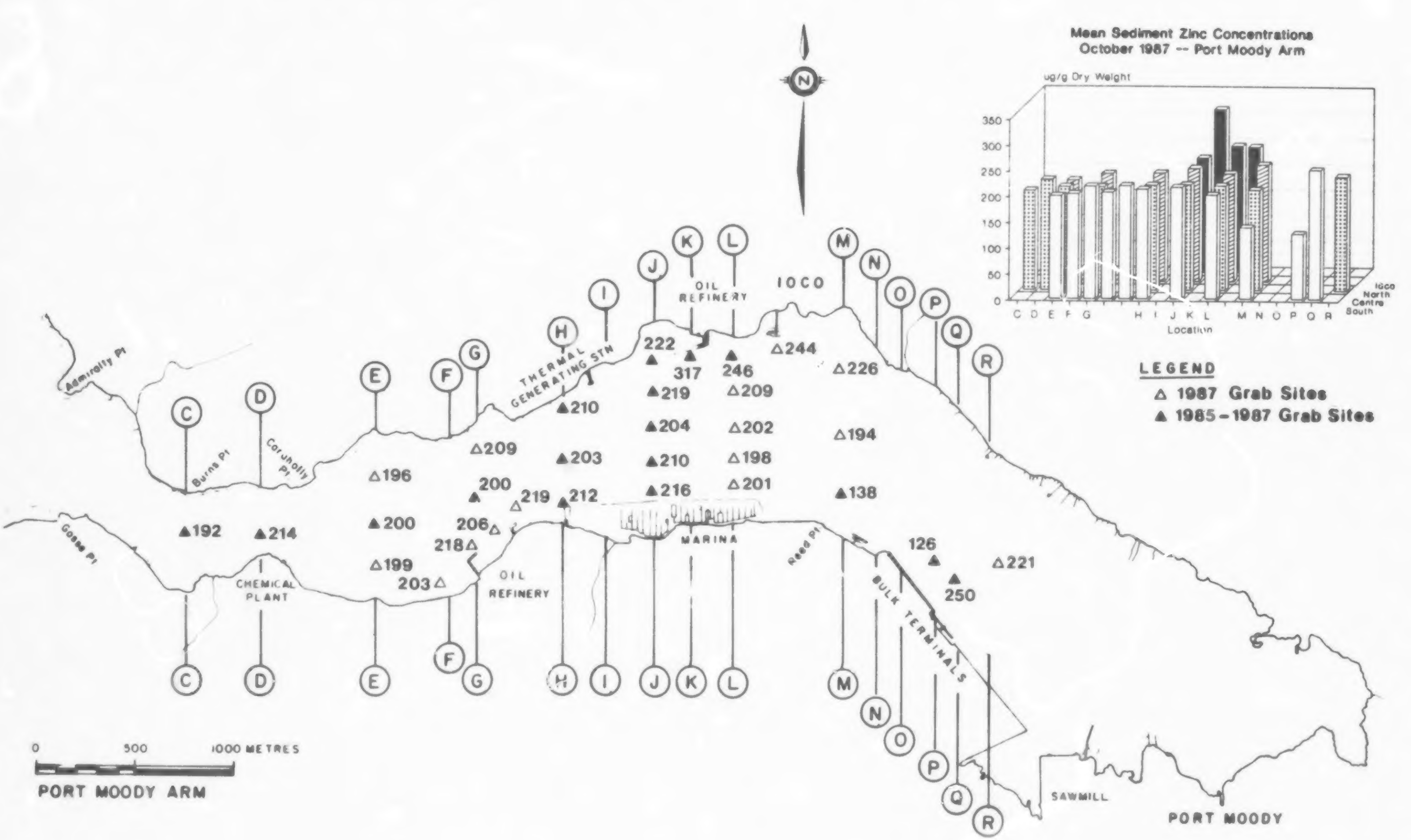
Mean Sediment Zinc Concentrations
October 1987 -- Port Moody Arm
ug/g Dry Weight
350
300
250
200
150
100
50
0
C D E F G H I J K L M N O P Q R
Location
Ioco
North
Centre
South
LEGEND
△ 1987 Grab Sites
▲ 1985-1987 Grab Sites
N
Admiralty Pt
Burns Pt
Caraholly Pt
Gosse Pt
CHEMICAL PLANT
THERMAL GENERATING STN
OIL REFINERY
IOCO
OIL REFINERY
MARINA
Reed Pt
BULK TERMINALS
SAWMILL
PORT MOODY
C
D
E
F
G
H
I
J
K
L
M
N
O
P
Q
R
▲192
▲214
△196
▲200
△199
203△
△209
200
206△
218△
△219
▲210
▲203
▲212
222
▲219
▲204
▲210
▲216
317
246
△209
△202
△198
△201
△244
△226
△194
▲138
126
250
△221
0
500
1000 METRES
PORT MOODY ARM

FIGURE 11 MEAN SURFACE SEDIMENT ZINC CONCENTRATIONS IN UG/G DRY WEIGHT (OCTOBER 1987) - PORT MOODY ARM

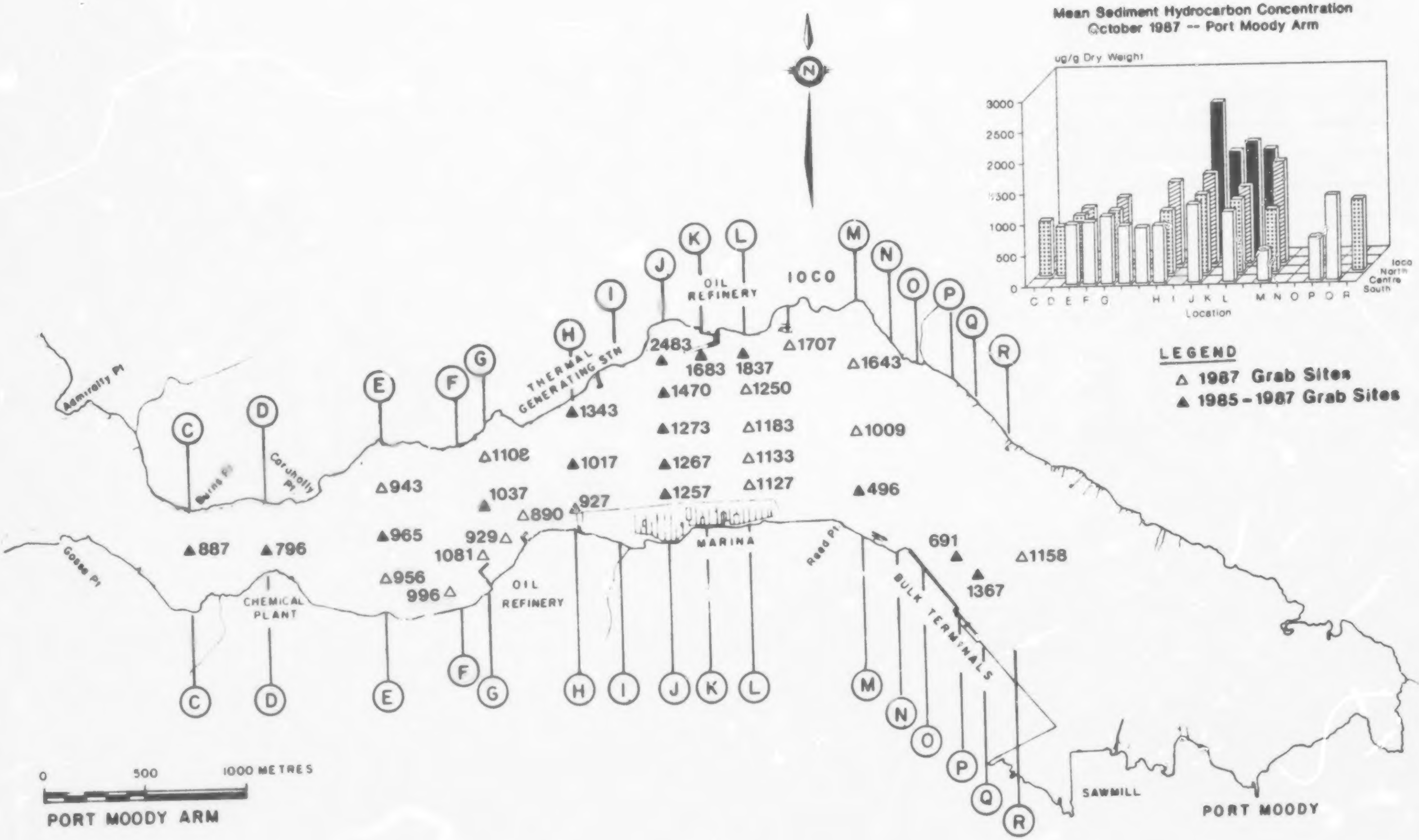
Mean Sediment Hydrocarbon Concentration
October 1987 -- Port Moody Arm
ug/g Dry Weight
3000
2500
2000
1500
1000
500
0
C D E F G H I J K L M N O P Q R
Location
Ioco
North
Centre
South
LEGEND
△ 1987 Grab Sites
▲ 1985-1987 Grab Sites
N
Admiralty Pt
Burns Pt
Gosse Pt
Cordnolly Pt
CHEMICAL PLANT
THERMAL GENERATING STN
OIL REFINERY
IOCO
MARINA
Reed Pt
BULK TERMINALS
SAWMILL
PORT MOODY
C
D
E
F
G
H
I
J
K
L
M
N
O
P
Q
R
▲887
▲796
△943
▲965
△956
996△
△1108
1037
929△
1081△
△890
▲1343
▲1017
927
2483
1683
1837
▲1470
▲1273
▲1267
▲1257
△1707
△1250
△1183
△1133
△1127
△1643
△1009
▲496
691
1367
△1158
0
500
1000 METRES
PORT MOODY ARM

FIGURE 12 MEAN SURFACE SEDIMENT HYDROCARBON CONCENTRATIONS IN UG/G DRY WEIGHT (OCTOBER 1987) - PORT MOODY ARM

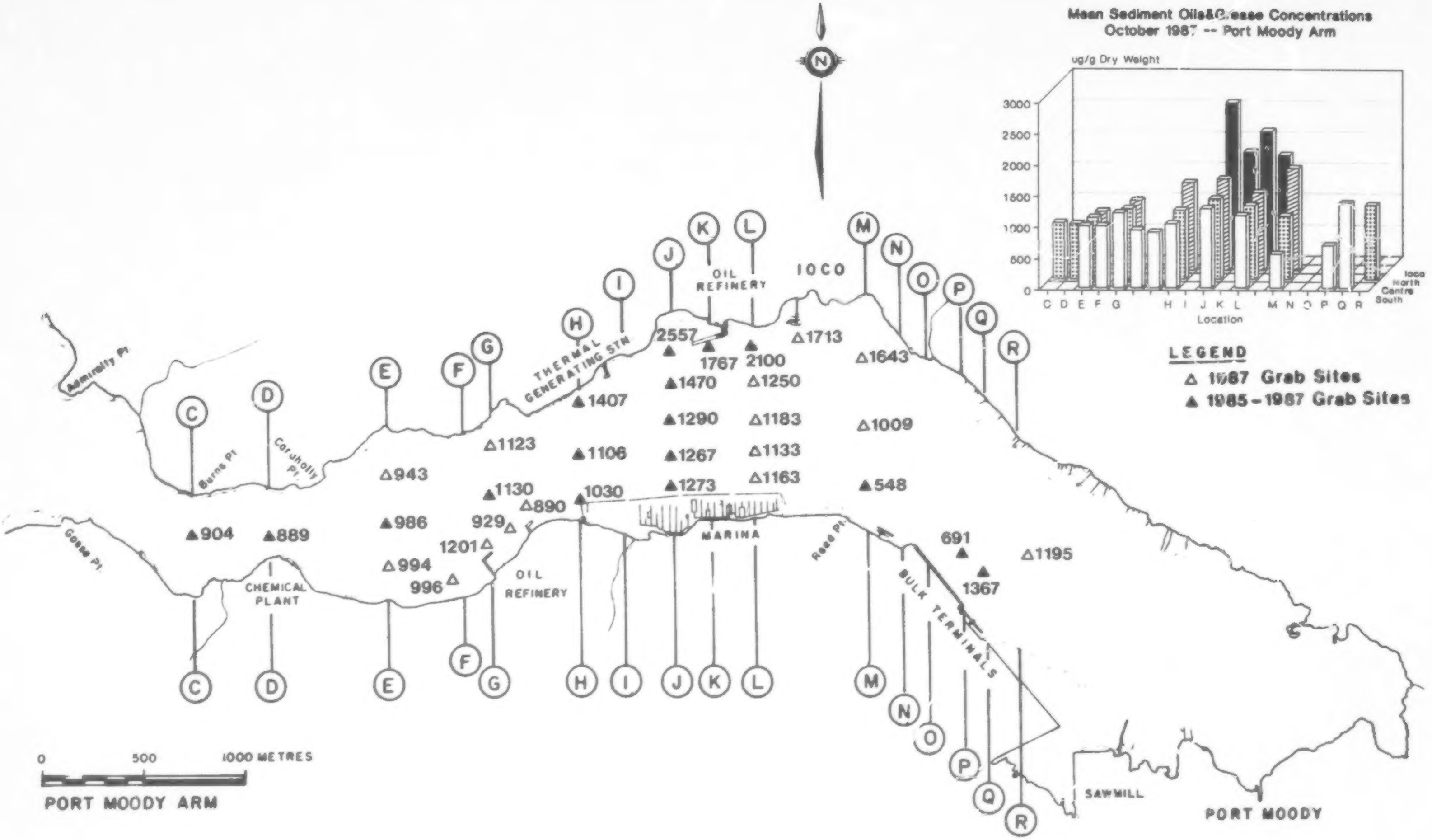
Mean Sediment Oils&Grease Concentrations
October 1987 -- Port Moody Arm
ug/g Dry Weight
3000
2500
2000
1500
1000
500
0
C D E F G H I J K L M N O P Q R
Location
Ioco
North
Centre
South
LEGEND
△ 1987 Grab Sites
▲ 1985-1987 Grab Sites
N
Admiralty Pt
Burns Pt
Caraholly Pt
Gosse Pt
CHEMICAL PLANT
OIL REFINERY
THERMAL GENERATING STN
OIL REFINERY
IOCO
MARINA
Reed Pt
BULK TERMINALS
SAWMILL
PORT MOODY
▲904
▲889
△943
▲986
△994
996△
1201△
929△
▲1130
△890
△1123
▲1407
▲1106
▲1030
2557▲
▲1470
▲1290
▲1267
▲1273
1767▲
2100▲
△1250
△1183
△1133
△1163
△1713
△1643
△1009
▲548
691▲
▲1367
△1195
C
D
E
F
G
H
I
J
K
L
M
N
O
P
Q
R
0
500
1000 METRES
PORT MOODY ARM

FIGURE 13 MEAN SURFACE SEDIMENT OILS AND GREASE CONCENTRATIONS IN UG/G DRY WEIGHT (OCTOBER 1987) - PORT MOODY ARM

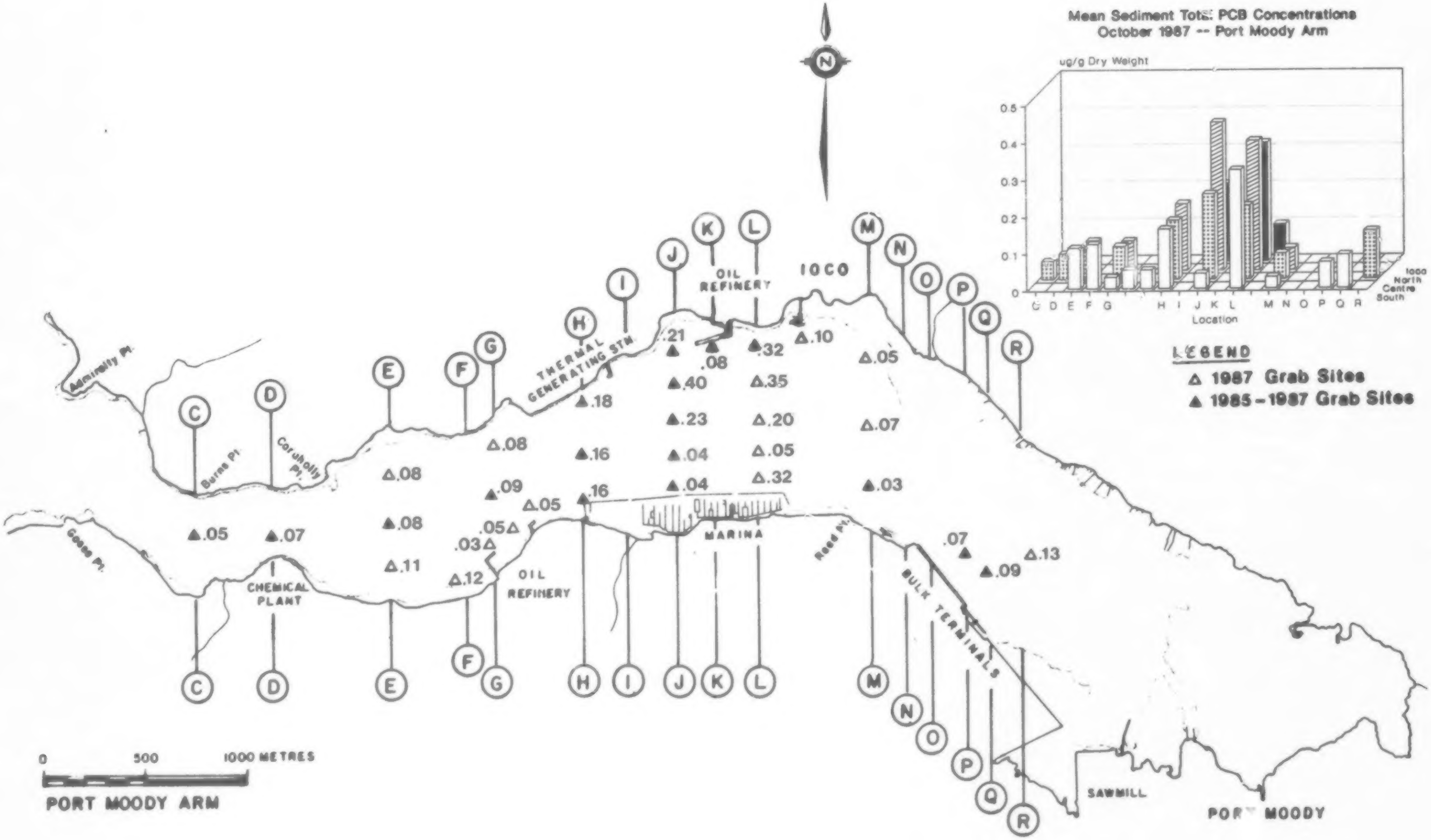
Mean Sediment Total PCB Concentrations
October 1987 -- Port Moody Arm
ug/g Dry Weight
0.5
0.4
0.3
0.2
0.1
0
C D E F G H I J K L M N O P Q R
Location
1000
North
Centre
South
LEGEND
△ 1987 Grab Sites
▲ 1985 - 1987 Grab Sites
N
Admiralty Pt.
Burns Pt.
Coruholly Pt.
Gosse Pt.
CHEMICAL PLANT
THERMAL GENERATING STN
OIL REFINERY
IOCO
OIL REFINERY
MARINA
Reed Pt.
BULK TERMINALS
SAWMILL
PORT MOODY
C
D
E
F
G
H
I
J
K
L
M
N
O
P
Q
R
▲.05
▲.07
△.08
▲.08
△.11
△.08
▲.09
△.05
.05△
.03△
△.12
▲.18
▲.16
▲.16
.21 ▲
▲.08
▲.40
▲.23
▲.04
▲.04
▲.32
△.35
△.20
△.05
△.32
△.10
△.05
△.07
▲.03
.07 ▲
▲.09
△.13
0 500 1000 METRES
PORT MOODY ARM

FIGURE 14 MEAN SURFACE SEDIMENT POLYCHLORINATED BIPHENYL (PCB) CONCENTRATIONS IN UG/G DRY WEIGHT (OCTOBER 1987) - PORT MOODY ARM

TABLE 2 A SUMMARY OF SEDIMENT POLYCYCLIC AROMATIC HYDROCARBON (PAH) CONCENTRATIONS ($\mu g/g$ DRY WEIGHT) IN VANCOUVER HARBOUR - OCTOBER 1987

				LOW MOLECULAR WEIGHT (MW) PAH						HIGH MOLECULAR WEIGHT (MW) PAH									
STN	Total PAH	Low MW PAH	High MW PAH	Naph-thalene	Acenaph-thylene	Acenaph-thene	Anthra-cene	Phenan-threne	Fluor-ene	Fluor-anthene	Py-rene	Chry-sene	Benzo(a) anthra-cene	Benzo(b)/(k)fluor-anthene	Benzo(a) pyrene	Benzo (g,h,i) perylene	Dibenzo (a,h)an-thracene	Benzo(e) pyrene	Indeno (1,2,3-cd) pyrene
PEI	1.76	0.31	1.45	0.10	<0.01	0.01	0.04	0.13	0.03	0.22	0.23	0.24	0.13	0.23	0.13	0.09	0.02	0.12	0.04
EB	3.83	0.79	3.04	0.28	0.06	0.02	0.10	0.26	0.07	0.39	0.64	0.44	0.30	0.39	0.34	0.09	0.19	0.04	0.22
15*	2.41	0.59	1.82	0.12	0.01	0.03	0.07	0.30	0.06	0.32	0.33	0.28	0.15	0.28	0.14	0.06	0.09	0.04	0.13
16*	3.53	0.83	2.70	0.17	0.03	0.05	0.11	0.39	0.08	0.53	0.74	0.38	0.22	0.30	0.19	0.04	0.11	0.02	0.17
19*	4.69	1.10	3.59	0.24	0.03	0.06	0.16	0.50	0.11	0.64	0.69	0.59	0.31	0.51	0.27	0.10	0.17	0.06	0.25
22A	12.22	2.29	9.93	0.51	0.04	0.16	0.32	1.00	0.26	1.44	1.70	1.48	0.78	1.66	0.86	0.40	0.72	0.16	0.73
25A	17.42	3.39	14.03	0.62	0.06	0.26	0.47	1.60	0.38	2.56	2.22	2.28	1.17	2.06	1.15	0.50	0.92	0.26	0.91
33B	4.41	1.13	3.28	0.33	0.05	0.05	0.20	0.41	0.09	0.47	0.52	0.47	0.22	0.54	0.30	0.14	0.26	0.08	0.28
36A*	4.04	1.07	2.97	0.39	0.07	0.04	0.09	0.39	0.09	0.40	0.48	0.39	0.19	0.49	0.28	0.13	0.26	0.07	0.28
36B	5.36	1.14	4.22	0.36	0.08	0.04	0.11	0.45	0.10	0.52	0.64	0.55	0.26	0.69	0.41	0.22	0.46	0.06	0.41
36C	17.19	5.64	11.55	0.66	0.08	0.48	0.47	3.13	0.82	3.34	2.47	1.68	0.92	1.26	0.65	0.19	0.43	0.05	0.56
37A*	7.31	1.53	5.78	0.61	0.13	0.05	0.12	0.52	0.10	0.70	0.92	0.66	0.28	0.88	0.54	0.30	0.86	0.07	0.57
39A	8.57	1.80	6.77	0.66	0.14	0.06	0.18	0.64	0.12	0.72	1.18	0.66	0.26	1.06	0.65	0.41	1.03	0.12	0.68
39C	6.08	1.60	4.48	0.60	0.16	0.06	0.14	0.54	0.10	0.64	0.88	0.48	0.21	0.64	0.38	0.22	0.54	0.07	0.42
39E	36.78	4.76	31.97	0.59	0.13	0.24	0.86	2.40	0.54	5.63	5.55	6.28	3.32	4.52	2.42	0.76	1.26	0.44	1.79
40	21.78	2.96	18.82	0.70	0.10	0.16	0.72	1.04	0.24	1.90	4.62	2.34	0.72	2.98	1.77	0.74	1.50	0.44	1.81
41A	8.03	1.45	6.58	0.50	0.08	0.06	0.18	0.51	0.12	0.67	1.06	0.96	0.33	1.12	0.58	0.28	0.60	0.30	0.68
41B	6.53	1.19	5.34	0.32	0.07	0.04	0.14	0.51	0.11	0.64	0.90	0.66	0.24	0.85	0.48	0.26	0.62	0.13	0.56
41D	5.55	1.50	4.05	0.58	0.14	0.04	0.12	0.52	0.10	0.60	0.82	0.46	0.19	0.58	0.32	0.19	0.45	0.08	0.36
42A*	4.86	1.63	3.23	0.65	0.12	0.06	0.12	0.56	0.12	0.56	0.72	0.43	0.16	0.44	0.24	0.09	0.25	0.06	0.28
42B*	5.02	1.14	3.88	0.40	0.06	0.04	0.09	0.46	0.09	0.65	0.71	0.50	0.19	0.58	0.29	0.17	0.42	0.04	0.33
42C*	4.66	1.09	3.57	0.30	0.04	0.07	0.10	0.49	0.09	0.62	0.62	0.43	0.24	0.56	0.29	0.16	0.36	0.02	0.27
47A*	4.46	1.06	3.40	0.29	0.04	0.04	0.09	0.50	0.10	0.57	0.60	0.47	0.20	0.50	0.26	0.13	0.30	0.06	0.31

* SINGLE SAMPLES (n = 1)

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APPENDIX I

VANCOUVER HARBOUR SAMPLING STATION CO-ORDINATES AND DEPTHS - OCTOBER 1987

APPENDIX I VANCOUVER HARBOUR SAMPLING STATION CO-ORDINATES AND DEPTHS - OCTOBER 1987

AREA	STATION	LATITUDE	LONGITUDE	DEPTH (m)
OUTER HARBOUR	PEI	49°19.78'N	123°13.97'W	66
	DD	49°19.70'N	123°11.65'W	35
	EB*	49°17.23'N	123°10.50'W	15
INNER HARBOUR				
North Shore	1	49°18.72'N	123°07.45'W	16
	2	49°18.65'N	123°07.27'W	14
Centre	15	49°18.00'N	123°05.00'W	36
	16	49°17.60'N	123°03.88'W	20
	19	49°17.52'N	123°06.30'W	21
South Shore	22A	49°17.13'N	123°05.09'W	14
	25A	49°17.28'N	122°04.62'W	14
PORT MOODY ARM	32	49°17.50'N	122°55.00'W	25
	33B	49°17.50'N	122°54.66'W	28
	34A	49°17.63'N	122°54.21'W	15
	34B	49°17.50'N	122°54.21'W	19
	34C	49°17.40'N	122°54.21'W	18
	36A	49°17.69'N	122°53.82'W	18
	36B	49°17.60'N	122°53.81'W	16
	36C	49°17.45'N	122°53.81'W	19
	36D	49°17.39'N	122°53.95'W	17
	36E	49°17.49'N	122°53.72'W	18
	36F	49°17.47'N	122°53.65'W	15
	37A	49°17.82'N	122°53.38'W	18
	37B	49°17.71'N	122°53.40'W	15
	37C	49°17.59'N	122°53.40'W	19
	39A	49°17.95'N	122°53.05'W	10
	39B	49°17.87'N	122°53.05'W	14
	39C	49°17.77'N	122°53.05'W	15
	39D	49°17.68'N	122°53.05'W	14
	39E	49°17.60'N	122°53.06'W	17
	40	49°17.98'N	122°52.87'W	9
	41A	49°17.98'N	122°52.73'W	10
	41B	49°18.03'N	122°52.48'W	12
	41C	49°17.89'N	122°52.73'W	12
	41D	49°17.80'N	122°52.72'W	12
	41E	49°17.70'N	122°52.72'W	12
	41F	49°17.60'N	122°52.72'W	14
	42A	49°17.96'N	122°52.21'W	8
	42B	49°17.80'N	122°52.21'W	9
	42C	49°17.61'N	122°52.21'W	14
	45	49°17.42'N	122°51.86'N	14
	46	49°17.37'N	122°51.74'W	14
	47A	49°14.40'N	122°51.56'W	17

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*EB - English Bay site sampled in October 1988

APPENDIX II

SURFACE SEDIMENT TRACE METAL CONCENTRATIONS
IN UG/G DRY WEIGHT (OCTOBER 1987)
- VANCOUVER HARBOUR

APPENDIX II SURFACE SEDIMENT TRACE METAL CONCENTRATIONS IN UG/G DRY WEIGHT (OCTOBER 1987) - VANCOUVER HARBOUR

Station	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	V	Zn
PEI	24000	<8	86.9	.20	51.2	181	38200	.150	13700	467	6	40	42	<8	62.4	78	138
	25100	<8	93.5	.26	52.3	173	38800	.150	13800	468	6	41	40	<8	64.7	81	144
	24700	<8	90.3	.26	51.7	185	38200	.150	13600	453	5	40	39	<8	63.1	80	145
DD	23900	<8	92.8	.36	49.8	297	38200	.188	12100	457	5	36	54	<8	70.4	90	155
	23400	<8	91.6	.39	49.1	301	37100	.170	12300	451	6	39	53	<8	68.4	85	158
	21700	<8	85.7	.40	47.9	296	36500	.160	11800	423	4	35	52	<8	65.5	82	159
1	21500	20	97.9	2.37	48.5	9760	42800	.173	10500	354	37	64	2060	<8	120.0	98	520
2	19700	10	78.5	2.81	49.2	6010	41000	.150	9020	322	22	86	929	<8	124.0	110	537
	20800	<8	86.5	2.98	51.2	6990	42200	.211	8790	325	21	130	1060	<8	125.0	120	547
	16600	17	68.4	2.53	51.8	6640	46400	.110	6980	283	27	140	1080	<8	264.0	150	470
22A	20000	<8	111.0	1.50	39.6	1360	33100	.252	10000	356	9	28	97	<8	73.0	72	329
	21200	<8	111.0	1.76	41.1	1230	33800	.253	9960	386	9	26	120	10	68.0	82	354
	19500	<8	123.0	1.95	37.6	1130	31500	.231	9580	349	10	26	130	<8	63.5	75	381
25A	16600	<8	96.8	2.26	48.9	447	28800	5.050	7940	291	10	30	436	10	64.1	70	360
	23000	<8	112.0	1.79	57.6	462	34700	1.320	11300	356	21	40	228	10	77.5	78	323
	22100	<8	114.0	1.98	54.2	423	32200	2.190	10200	334	17	30	222	10	71.6	75	313
32	25700	<8	99.1	.73	50.7	226	37000	.324	11700	392	7	28	78	<8	79.0	80	195
	25700	<8	100.0	.77	51.3	220	37400	.319	11700	396	7	26	77	<8	81.9	80	192
	24900	<8	95.6	.89	49.8	224	35600	.297	11500	389	7	27	78	9	77.1	79	188
33B	25800	<8	98.3	.54	53.3	209	37400	.333	11300	383	6	27	78	<8	81.5	79	192
	26100	<8	107.0	1.20	53.8	235	45200	.338	11700	386	7	26	78	<8	89.0	81	220
	26100	<8	110.0	1.87	53.3	248	48200	.282	12000	384	8	25	82	<8	85.9	79	230
34A	28600	<8	103.0	.75	67.2	213	38200	.380	12600	405	6	28	90	<8	84.5	85	201
	26900	<8	98.4	.73	62.1	199	37300	.358	12400	385	7	27	80	<8	84.1	78	192
	27000	<8	98.4	.50	67.6	207	37100	.389	12500	391	7	27	87	<8	80.7	82	195

APPENDIX II SURFACE SEDIMENT TRACE METAL CONCENTRATIONS IN UG/G DRY WEIGHT (OCTOBER 1987) - VANCOUVER HARBOUR (CONT'D)

Station	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	V	Zn
34B	27800	<8	105.0	.78	61.8	209	39700	.342	12200	400	5	27	89	10	86.6	84	202
	27000	<8	101.0	.75	59.2	207	38800	.360	12000	395	6	28	89	<8	84.6	82	200
	28000	<8	104.0	.83	61.7	206	38700	.356	12500	399	7	29	84	<8	86.3	85	198
34C	28200	<8	106.0	.73	58.5	210	36900	.353	12000	394	8	28	87	10	83.1	84	203
	28800	<8	107.0	.92	59.8	213	37300	.363	12800	392	10	29	90	8	84.5	83	193
	28300	<8	107.0	29.00	58.2	208	37300	.383	12100	389	7	28	87	<8	85.7	82	202
36A	26300	<8	91.4	.89	69.7	188	36100	.328	12200	378	7	29	93	<8	75.1	79	200
	28100	<8	97.6	.86	75.9	188	37200	.384	12700	386	8	29	99	<8	78.5	82	218
	28700	<8	102.0	.97	72.5	189	36800	.374	12100	388	8	29	96	<8	80.7	84	208
36B	26100	<8	95.0	1.00	63.2	268	36200	.276	11400	371	7	28	91	<8	77.6	79	200
	26700	<8	93.7	.95	64.9	244	36100	.313	11600	379	6	28	100	<8	76.1	82	202
	26700	<8	96.2	.92	63.2	201	36000	.361	11500	373	5	27	95	<8	76.4	82	198
36C	24700	<8	87.4	.86	52.8	138	38100	.240	11400	376	5	24	63	<8	81.7	76	181
	26600	<8	94.8	12.60	60.4	178	38200	.327	11400	378	5	26	85	8	93.1	80	243
	26400	<8	96.9	1.20	57.7	171	38200	.313	11000	360	7	24	83	<8	94.4	79	230
36D	29200	<8	106.0	.84	64.0	202	37200	.354	12900	398	9	28	90	<8	86.6	86	201
	30000	<8	108.0	1.10	63.2	207	38000	.338	12900	404	7	29	93	9	86.3	87	205
	28300	<8	104.0	.98	59.3	198	37300	.391	11900	386	7	28	92	<8	81.1	82	202
36E	27600	<8	103.0	.87	58.4	168	42100	.315	11800	387	7	26	81	8	85.3	82	193
	28300	<9	106.0	1.00	62.0	187	42000	.357	12000	390	6	29	93	<9	87.2	84	215
	28600	<8	107.0	1.00	61.7	186	43400	.424	12400	396	6	26	88	<8	84.5	85	211
36F	26700	<8	98.3	.93	59.7	180	40000	.351	11700	367	7	26	92	<8	82.2	80	208
	25700	<8	92.5	.94	56.3	166	36500	.351	10500	361	8	24	84	<8	79.2	78	237
	25500	<8	91.2	.94	59.6	174	39000	.336	10900	362	7	25	91	<8	80.1	78	212

APPENDIX II SURFACE SEDIMENT TRACE METAL CONCENTRATIONS IN UG/G DRY WEIGHT (OCTOBER 1987) - VANCOUVER HARBOUR (CONT'D)

Station	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	V	Zn
37A	27100	<8	95.0	1.10	72.2	180	36400	.368	12000	373	7	30	99	<8	76.5	82	213
	27000	<8	90.8	1.20	76.8	154	36000	.394	11800	377	6	29	130	<8	73.4	83	210
	27100	<8	94.1	1.50	74.6	149	35600	.404	11800	379	8	29	99	<8	74.3	84	207
37B	25600	<8	92.9	1.10	60.0	150	38700	.454	11400	362	6	26	94	<8	74.5	78	205
	25300	<8	92.8	1.20	58.5	152	40000	.400	10900	365	7	27	98	<8	76.8	80	208
	24300	<8	87.4	1.10	57.3	143	37200	.465	10800	351	6	25	87	<8	72.8	77	195
37C	25100	<8	87.8	1.30	59.5	161	37800	.393	10900	356	6	25	93	<8	75.7	79	211
	25000	<8	86.8	1.20	59.3	154	37100	.377	11100	350	8	25	91	<8	73.1	77	212
	25900	<8	93.0	1.30	59.3	160	37100	.356	10600	351	7	25	89	<8	80.1	79	212
39A	26800	<8	90.3	1.78	97.2	149	34900	.369	11300	366	10	30	120	<8	69.2	80	227
	27400	<8	111.0	1.60	49.5	142	38200	.507	12100	382	20	31	110	<8	75.8	80	188
	28300	<8	96.7	1.94	93.5	164	36500	.426	11200	378	10	34	171	<8	70.0	94	250
39B	26200	<8	89.4	1.40	67.3	124	35100	.416	11300	368	10	29	110	<8	70.7	78	205
	26900	<8	91.3	1.60	76.1	136	35100	.371	11500	372	8	29	96	<8	71.8	79	210
	26900	<8	91.8	2.23	81.2	138	35200	.363	11200	367	8	29	120	<8	68.8	79	242
39C	27300	<8	94.3	1.60	88.1	128	35700	.346	11800	377	6	32	85	<8	79.9	81	199
	27300	<8	94.0	1.40	79.7	136	36400	.371	11400	371	8	29	98	<8	73.5	81	203
	27400	<8	93.5	1.20	69.5	143	36800	.356	11700	378	7	29	97	<8	74.1	82	209
39D	26000	<8	89.7	1.20	62.9	144	37200	.366	11500	367	7	27	91	<8	75.0	77	213
	24900	<8	86.6	1.40	60.9	138	35900	.349	10800	356	7	26	95	<8	73.8	76	205
	26900	<8	98.9	1.30	61.8	144	37200	.390	11200	370	7	28	91	<8	78.0	80	211
39E	27200	<8	93.5	1.50	65.7	151	36900	.406	11300	372	7	28	96	<8	77.7	82	222
	25400	<8	89.2	1.30	62.0	137	35000	.359	10700	347	9	25	92	<8	79.1	78	205
	26100	<8	93.1	1.40	61.5	144	35200	.346	10700	356	8	26	95	<8	78.1	78	222

APPENDIX II SURFACE SEDIMENT TRACE METAL CONCENTRATIONS IN UG/G DRY WEIGHT (OCTOBER 1987) - VANCOUVER HARBOUR (CONT'D)

Station	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	V	Zn
40	26900	<8	156.0	2.15	97.2	138	38100	.488	11700	367	10	34	360	10	128.0	83	324
	26800	<8	129.0	2.80	91.6	139	35800	.454	11700	352	10	28	290	10	285.0	79	340
	28400	<8	103.0	4.35	99.6	126	35900	.484	11600	361	10	33	244	18	161.0	84	288
41A	29800	<8	102.0	1.88	118.0	143	37200	.330	12300	376	10	26	120	<8	81.3	82	245
	28600	<8	96.0	2.00	128.0	143	36000	.323	11700	367	10	27	120	<8	76.4	81	247
	30400	<8	105.0	2.04	138.0	147	37100	.339	12500	380	10	28	120	<8	84.3	85	246
41B	27800	<8	90.8	13.60	115.0	138	35800	.305	12200	362	8	26	110	<8	80.1	76	251
	27200	10	87.9	1.80	108.0	133	35200	.277	11700	353	10	25	110	<8	73.6	76	237
	28400	<8	94.7	2.00	112.0	134	36600	.296	11800	371	10	29	110	<8	78.2	77	243
41C	26600	<8	88.3	1.78	78.0	132	35800	.283	11300	357	9	27	93	<8	70.0	76	209
	27800	<8	93.0	1.70	78.3	133	37200	.286	12800	371	9	27	88	<8	78.7	79	214
	26400	<8	88.4	1.50	78.2	128	35200	.280	11600	355	9	26	78	<8	71.8	75	205
41D	28000	10	93.4	1.71	72.8	132	37500	.288	12400	380	10	29	84	<8	76.3	82	208
	26700	<8	91.9	1.50	65.3	118	34900	.363	12900	358	10	28	67	<8	76.9	76	195
	26900	<8	89.9	2.30	70.9	188	36000	.436	11900	367	10	28	97	10	73.7	79	202
41E	27100	<8	90.4	1.60	68.7	135	37000	.354	11600	368	8	26	84	<8	72.3	78	198
	26500	<8	86.6	1.60	66.6	134	35400	.309	11500	362	8	26	83	<8	68.4	77	199
	28000	<8	95.9	1.86	67.1	122	36300	.294	12300	371	9	28	74	<8	77.6	81	197
41F	27500	<8	93.6	1.76	65.1	131	37000	.274	12100	368	10	28	80	<8	76.4	81	203
	25500	<8	89.9	1.70	60.3	119	34500	.266	10700	341	7	24	80	<8	72.1	74	195
	27000	<8	93.3	1.60	63.3	126	35800	.373	11400	358	8	27	74	<8	74.8	79	204
42A	26900	<8	85.4	2.41	86.8	114	33300	.269	11200	336	8	24	93	<8	72.6	75	229
	25600	<8	79.9	2.46	82.9	115	33000	.287	10800	329	9	24	100	<8	70.3	73	217
	26500	<8	80.0	2.59	89.5	119	34300	.266	11000	342	8	25	95	<8	71.2	75	231

APPENDIX II SURFACE SEDIMENT TRACE METAL CONCENTRATIONS IN UG/G DRY WEIGHT (OCTOBER 1987) - VANCOUVER HARBOUR (CONCLUDED)

Station	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	V	Zn
42B	27000	<8	88.1	2.05	67.1	103	34700	.229	11600	352	8	24	61	<8	72.0	72	191
	27500	<8	90.5	4.71	66.1	104	35400	.236	11600	363	9	25	61	<8	71.7	74	192
	29000	<8	97.6	6.16	69.5	107	36300	.230	12200	367	10	25	65	<8	78.5	76	199
42C	28600	<8	93.0	1.79	54.0	74	37400	.130	12900	408	9	30	25	<8	71.1	80	135
	26900	<8	88.1	1.70	48.3	64	34900	.140	12800	386	9	29	20	<8	70.6	74	117
	28700	<8	97.6	2.36	55.7	80	38200	.170	13200	402	9	28	34	<8	79.8	80	162
45	24900	<8	79.4	1.89	46.6	60	34200	.100	12000	380	10	29	10	<8	64.3	71	123
	24400	<8	77.8	1.95	49.5	77	34400	.130	11900	367	10	33	23	<8	65.1	70	150
	24700	<8	73.7	1.10	37.9	47	27500	.098	10800	328	8	22	24	<8	62.0	57	106
46	26300	<8	84.2	2.77	61.4	102	35200	.197	11800	363	10	28	60	<8	70.6	70	237
	27500	<8	89.1	3.01	66.7	111	35900	.205	11700	374	10	28	69	<8	72.7	74	269
	28500	<8	91.9	2.84	65.0	108	37600	.238	12200	391	10	30	63	<8	74.2	75	244
47A	30600	<8	98.1	2.99	69.9	118	38600	.209	12700	403	10	31	74	<8	78.4	78	229
	29300	<8	93.7	2.93	66.7	112	37500	.203	12500	394	10	31	66	<8	75.4	74	216
	28100	<8	88.8	3.32	65.8	113	35900	.183	13000	380	10	29	68	<8	79.9	74	219
LIA*	27500	<8	113.0	.51	32.2	56	32700	.120	14600	2410	7	24	22	<8	93.5	110	121
	28500	<8	117.0	.65	33.3	59	33800	.120	15000	2480	8	25	22	<8	98.1	120	124
	31200	<8	128.0	.52	35.9	72	36200	.130	16300	2650	4	20	23	<8	109.0	130	135
LIB*	28600	<8	95.2	.32	38.3	65	29300	.120	13700	546	3	18	22	<8	92.8	100	102
	29000	<8	95.8	.31	38.0	65	29800	.120	13700	562	3	20	22	<8	92.2	100	104
	29500	<8	97.6	.30	38.8	66	29800	.120	14100	569	3	25	21	<8	96.7	100	102

*LI - Loughborough Inlet, reference sites sampled in July 1987 (see Figure 1)

APPENDIX III

DESCRIPTIVE STATISTICS OF SURFACE SEDIMENT TRACE METAL CONCENTRATIONS IN UG/G DRY WEIGHT
OCTOBER 1987 - VANCOUVER HARBOUR

APPENDIX III DESCRIPTIVE STATISTICS OF SURFACE SEDIMENT TRACE METAL CONCENTRATIONS IN UG/G DRY WEIGHT (OCTOBER 1987) - VANCOUVER HARBOUR

Station	Statistic	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	V	Zn
PEI	MEAN(3)	24600	-	90.2	0.24	51.7	180	38400	0.150	13700	463	6	40	40	-	63.4	80	142
	S.D.	557	-	3.3	0.03	0.6	6	346	0	100	8	1	1	2	-	1.2	2	4
	C.V.(%)	2	-	4	14	1	3	1	0	1	2	10	1	4	-	2	2	3
	MAX.	25100	<8	93.5	0.26	52.3	185	38800	0.150	13800	468	6	41	42	<8	64.7	81	145
	MIN.	24000	<8	86.9	0.20	51.2	173	38200	0.150	13600	453	5	40	39	<8	62.4	78	138
DD	MEAN(3)	23000	-	90.0	0.38	48.9	298	37267	0.173	12067	444	5	37	53	-	68.1	86	157
	S.D.	1153	-	3.8	0.02	1.0	3	862	0	252	18	1	2	1	-	2.5	4	2
	C.V.(%)	5	-	4	5	2	1	2	8	2	4	20	6	2	-	4	5	1
	MAX.	23900	<8	92.8	0.40	49.8	301	38200	0.188	12300	457	6	39	54	<8	70.4	90	159
	MIN.	21700	<8	85.7	0.36	47.9	296	36500	0.160	11800	423	4	35	52	<8	65.5	82	155
1	VALUE	21500	20	97.9	2.37	48.5	9760	42800	0.173	10500	354	37	64	2060	-	120.0	98	520
2	MEAN(3)	19033	12	77.8	2.77	50.7	6546	43200	0.157	8263	310	23	119	1023	-	171.0	127	518
	S.D.	2178	5	9.1	0.23	1.4	497	2835	0.051	1117	23	3	29	82	-	80.5	21	42
	C.V.(%)	11	40	12	8	3	8	7	32	14	8	14	24	8	-	47	16	8
	MAX.	20800	17	86.5	2.98	51.8	6990	46400	0.211	9020	325	27	140	1080	<8	264.0	150	547
	MIN.	16600	<8	68.4	2.53	49.2	6010	41000	0.110	6980	283	21	86	929	<8	124.0	110	470
22A	MEAN(3)	20233	-	115.0	1.74	39.4	1240	32800	0.245	9847	364	9	27	116	9	68.2	76	355
	S.D.	874	-	6.9	0.23	1.8	115	1179	0.012	232	20	1	1	17	1	4.8	5	26
	C.V.(%)	4	-	6	13	4	9	4	5	2	5	6	4	15	13	7	7	7
	MAX.	21200	<8	123.0	1.95	41.1	1360	33800	0.253	10000	386	10	28	130	10	73.0	82	381
	MIN.	19500	<8	111.0	1.50	37.6	1130	31500	0.231	9580	349	9	26	97	<8	63.5	72	329

APPENDIX III DESCRIPTIVE STATISTICS OF SURFACE SEDIMENT TRACE METAL CONCENTRATIONS IN UG/G DRY WEIGHT (OCTOBER 1987)
- VANCOUVER HARBOUR (Continued)

Station	Statistic	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	V	Zn
25A	MEAN(3)	20567	-	107.6	2.01	53.6	444	31900	2.853	9813	327	16	33	295	10	71.1	74	332
	S.D.	3465	-	9.4	0.24	4.4	20	2961	1.951	1713	33	6	6	122	0	6.7	4	25
	C.V.(%)	17	-	9	12	8	4	9	68	18	10	35	17	41	0	10	5	8
	MAX.	23000	<8	114.0	2.26	57.6	462	34700	5.050	11300	356	21	40	436	10	77.5	78	360
	MIN.	16600	<8	96.8	1.79	48.9	423	28800	1.320	7940	291	10	30	222	10	64.1	70	313
32	MEAN(3)	25433	-	98.2	0.80	50.6	223	36667	0.313	11633	392	7	27	78	8	79.3	80	192
	S.D.	462	-	2.3	0.08	0.8	3	945	0.014	115	4	0	1	1	.6	2.4	1	4
	C.V.(%)	2	-	2	10	2	1	3	5	1	1	0	4	1	7	3	1	2
	MAX.	25700	<8	100.0	0.89	51.3	226	37400	0.324	11700	396	7	28	78	9	81.9	80	195
	MIN.	24900	<8	95.6	0.73	49.8	220	35600	0.297	11500	389	7	26	77	<8	77.1	79	188
33B	MEAN(3)	26000	-	105.1	1.20	53.5	231	43600	0.318	11667	384	7	26	79	-	85.5	80	214
	S.D.	173	-	6.1	0.67	0.3	20	5575	0.031	351	2	1	1	2	-	3.8	1	20
	C.V.(%)	1	-	6	55	0	9	13	10	3	0	14	4	3	-	4	1	9
	MAX.	26100	<8	110.0	1.87	53.8	248	48200	0.338	12000	386	8	27	82	<8	89.0	81	230
	MIN.	25800	<8	98.3	0.54	53.3	209	37400	0.282	11300	383	6	25	78	<8	81.5	79	192
34A	MEAN(3)	27500	-	99.9	0.66	65.6	206	37533	0.376	12500	394	7	27	86	-	83.1	82	196
	S.D.	954	-	2.7	0.14	3.1	7	586	0.016	100	10	1	1	5	-	2.1	4	5
	C.V.(%)	4	-	3	21	5	3	2	4	1	3	9	2	6	-	2	4	2
	MAX.	28600	<8	103.0	0.75	67.6	213	38200	0.389	12600	405	7	28	90	<8	84.5	85	201
	MIN.	26900	<8	98.4	0.50	62.1	199	37100	0.358	12400	385	6	27	80	<8	80.7	78	192
34B	MEAN(3)	27600	-	103.3	0.79	60.9	207	39067	0.353	12233	398	6	28	87	9	85.8	84	200
	S.D.	529	-	2.1	0.04	1.5	2	551	0.009	252	3	1	1	3	1	1.1	2	2
	C.V.(%)	2	-	2	5	2	1	1	3	2	1	17	4	3	13	1	2	1
	MAX.	28000	<8	105.0	0.83	61.8	209	39700	0.360	12500	400	7	29	89	10	86.6	85	202
	MIN.	27000	<8	101.0	0.75	59.2	206	38700	0.342	12000	395	5	27	84	<8	84.6	82	198

APPENDIX III DESCRIPTIVE STATISTICS OF SURFACE SEDIMENT TRACE METAL CONCENTRATIONS IN UG/G DRY WEIGHT (OCTOBER 1987)
- VANCOUVER HARBOUR (Continued)

Station	Statistic	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	V	Zn
34C	MEAN(3)	28433	–	106.7	10.22	58.8	210	37167	0.366	12300	392	8	28	88	9	84.4	83	199
	S.D.	321	–	0.6	16.27	0.9	2	231	0.015	436	3	2	1	2	1	1.3	1	6
	C.V.(%)	1	–	0	159	1	1	1	4	4	1	18	2	2	13	2	1	3
	MAX.	28800	<8	107.0	29.00	59.8	213	37300	0.383	12800	394	10	29	90	10	85.7	84	203
	MIN.	28200	<8	106.0	0.73	58.2	208	36900	0.353	12000	389	7	28	87	<8	83.1	82	193
36A	MEAN(3)	27700	–	97.0	0.91	72.7	188	36700	0.362	12333	384	8	29	96	–	78.1	82	209
	S.D.	1249	–	5.3	0.06	3.1	1	557	0.030	321	5	1	0	3	–	2.8	3	9
	C.V.(%)	4	–	6	6	4	0	2	8	3	1	8	–	3	–	4	3	4
	MAX.	28700	<8	102.0	0.97	75.9	189	37200	0.384	12700	388	8	29	99	<8	80.7	84	218
	MIN.	26300	<8	91.4	0.86	69.7	188	36100	0.328	12100	378	7	29	93	<8	75.1	79	200
36B	MEAN(3)	26500	–	95.0	0.96	63.8	238	36100	0.317	11500	374	6	28	95	–	76.7	81	200
	S.D.	346	–	1.3	0.04	1.0	34	100	0.043	100	4	1	1	5	–	0.8	2	2
	C.V.(%)	1	–	1	4	2	14	0	14	1	1	17	2	5	–	1	2	1
	MAX.	26700	<8	96.2	1.00	64.9	268	36200	0.361	11600	379	7	28	100	<8	77.6	82	202
	MIN.	26100	<8	93.7	0.92	63.2	201	36000	0.276	11400	371	5	27	91	<8	76.1	79	198
36C	MEAN(3)	25900	–	93.0	4.89	57.0	162	38167	0.293	11267	371	6	25	77	8	89.7	78	218
	S.D.	1044	–	5.0	6.68	3.9	21	58	0.047	231	10	1	1	12	0	7.0	2	33
	C.V.(%)	4	–	5	137	7	13	0	16	2	3	20	5	16	0	8	3	15
	MAX.	26600	<8	96.9	12.60	60.4	178	38200	0.327	11400	378	7	26	85	8	94.4	80	243
	MIN.	24700	<8	87.4	0.86	52.8	138	38100	0.240	11000	360	5	24	63	<8	81.7	76	181
36D	MEAN(3)	29167	–	106.0	0.97	62.2	202	37500	0.361	12567	396	8	28	92	8	84.7	85	203
	S.D.	850	–	2.0	0.13	2.5	4	436	0.027	577	9	1	1	2	.6	3.1	3	2
	C.V.(%)	3	–	2	13	4	2	1	8	5	2	15	2	2	7	4	3	1
	MAX.	30000	<8	108.0	1.10	64.0	207	38000	0.391	12900	404	9	29	93	9	86.6	87	205
	MIN.	28300	<8	104.0	0.84	59.3	198	37200	0.338	11900	386	7	28	90	<8	81.1	82	201

APPENDIX III DESCRIPTIVE STATISTICS OF SURFACE SEDIMENT TRACE METAL CONCENTRATIONS IN UG/G DRY WEIGHT (OCTOBER 1987) - VANCOUVER HARBOUR (Continued)

Station	Statistic	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	V	Zn
36E	MEAN(3)	28167	-	105.3	0.96	60.7	180	42500	0.365	12067	391	6	27	87	8	85.7	84	206
	S.D.	513	-	2.1	0.08	2.0	11	781	0.055	306	5	1	2	6	.6	1.4	2	12
	C.V.(%)	2	-	2	8	3	6	2	15	2	1	9	6	7	7	2	2	6
	MAX.	28600	<9	107.0	1.00	62.0	187	43400	0.424	12400	396	7	29	93	<9	87.2	85	215
	MIN.	27600	<8	103.0	0.87	58.4	168	42000	0.315	11800	387	6	26	81	<8	84.5	82	193
36F	MEAN(3)	25967	-	94.0	0.94	58.5	173	38500	0.346	11033	363	7	25	89	-	80.5	79	219
	S.D.	643	-	3.8	0.01	1.9	7	1803	0.009	611	3	1	1	4	-	1.5	1	16
	C.V.(%)	2	-	4	1	3	4	5	2	6	1	8	4	5	-	2	2	7
	MAX.	26700	<8	98.3	0.94	59.7	180	40000	0.351	11700	367	8	26	92	<8	82.2	80	237
	MIN.	25500	<8	91.2	0.93	56.3	166	36500	0.336	10500	361	7	24	84	<8	79.2	78	208
37A	MEAN(3)	27067	-	93.3	1.27	74.5	161	36000	0.389	11867	376	7	29	109	-	74.7	83	210
	S.D.	58	-	2.2	0.21	2.3	17	400	0.019	115	3	1	1	18	-	1.6	1	3
	C.V.(%)	0	-	2	16	3	10	1	5	1	1	14	2	16	-	2	1	1
	MAX.	27100	<8	95.0	1.50	76.8	180	36400	0.404	12000	379	8	30	130	<8	76.5	84	213
	MIN.	27000	<8	90.8	1.10	72.2	149	35600	0.368	11800	373	6	29	99	<8	73.4	82	207
37B	MEAN(3)	25067	-	91.0	1.13	58.6	148	38633	0.440	11033	359	6	26	93	-	74.7	78	203
	S.D.	681	-	3.1	0.06	1.4	5	1401	0.035	321	7	1	1	6	-	2.0	2	7
	C.V.(%)	3	-	4	5	2	3	4	8	3	2	9	4	6	-	3	2	3
	MAX.	25600	<8	92.9	1.20	60.0	152	40000	0.465	11400	365	7	27	98	<8	76.8	80	208
	MIN.	24300	<8	87.4	1.10	57.3	143	37200	0.400	10800	351	6	25	87	<8	72.8	77	195
37C	MEAN(3)	25333	-	89.2	1.27	59.4	158	37333	0.375	10867	352	7	25	91	-	76.3	78	212
	S.D.	493	-	3.3	0.06	0.1	4	404	0.019	252	3	1	0	2	-	3.5	1	1
	C.V.(%)	2	-	4	5	0	2	1	5	2	1	14	0	2	-	5	2	0
	MAX.	25900	<8	93.0	1.30	59.5	161	37800	0.393	11100	356	8	25	93	<8	80.1	79	212
	MIN.	25000	<8	86.8	1.20	59.3	154	37100	0.356	10600	350	6	25	89	<8	73.1	77	211

APPENDIX III DESCRIPTIVE STATISTICS OF SURFACE SEDIMENT TRACE METAL CONCENTRATIONS IN UG/G DRY WEIGHT (OCTOBER 1987) - VANCOUVER HARBOUR (Continued)

Station	Statistic	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	V	Zn
39A	MEAN(3)	27500	-	99.3	1.77	80.1	152	36533	0.434	11533	375	13	32	134	-	71.7	85	222
	S.D.	755	-	10.6	0.17	26.5	11	1650	0.069	493	8	6	2	33	-	3.6	8	31
	C.V.(%)	3	-	11	10	33	7	4	16	4	2	43	7	24	-	5	10	14
	MAX.	28300	<8	111.0	1.94	97.2	164	38200	0.507	12100	382	20	34	171	<8	75.8	94	250
	MIN.	26800	<8	90.3	1.60	49.5	142	34900	0.369	11200	366	10	30	110	<8	69.2	80	188
39B	MEAN(3)	26667	-	90.8	1.74	74.9	133	35133	0.383	11333	369	9	29	109	-	70.4	79	219
	S.D.	404	-	1.3	0.43	7.0	8	58	0.029	153	3	1	0	12	-	1.5	1	20
	C.V.(%)	2	-	1	25	9	6	0	8	1	1	13	0	11	-	2	1	9
	MAX.	26900	<8	91.8	2.23	81.2	138	35200	0.416	11500	372	10	29	120	<8	71.8	79	242
	MIN.	26200	<8	89.4	1.40	67.3	124	35100	0.363	11200	367	8	29	96	<8	68.8	78	205
39C	MEAN(3)	27333	-	93.9	1.40	79.1	136	36300	0.358	11633	375	7	30	93	-	75.8	81	204
	S.D.	58	-	0.4	0.20	9.3	8	557	0.013	208	4	1	2	7	-	3.5	1	5
	C.V.(%)	0	-	0	14	12	6	2	4	2	1	14	6	8	-	5	1	2
	MAX.	27400	<8	94.3	1.60	88.1	143	36800	0.371	11800	378	8	32	98	<8	79.9	82	209
	MIN.	27300	<8	93.5	1.20	69.5	128	35700	0.346	11400	371	6	29	85	<8	73.5	81	199
39D	MEAN(3)	25933	-	91.7	1.30	61.9	142	36767	0.368	11167	364	7	27	92	-	75.6	78	210
	S.D.	1002	-	6.4	0.10	1.0	4	751	0.021	351	7	0	1	2	-	2.2	2	4
	C.V.(%)	4	-	7	8	2	2	2	6	3	2	0	4	2	-	3	3	2
	MAX.	26900	<8	98.9	1.40	62.9	144	37200	0.390	11500	370	7	28	95	<8	78.0	80	213
	MIN.	24900	<8	86.6	1.20	60.9	138	35900	0.349	10800	356	7	26	91	<8	73.8	76	205
39E	MEAN(3)	26233	-	91.9	1.40	63.1	144	35700	0.370	10900	358	8	26	94	-	78.3	79	216
	S.D.	907	-	2.4	0.10	2.3	7	1044	0.032	346	13	1	2	2	-	0.7	2	10
	C.V.(%)	4	-	3	7	4	5	3	8	3	4	12	6	2	-	1	3	4
	MAX.	27200	<8	93.5	1.50	65.7	151	36900	0.406	11300	372	9	28	96	<8	79.1	82	222
	MIN.	25400	<8	89.2	1.30	61.5	137	35000	0.346	10700	347	7	25	92	<8	77.7	78	205

APPENDIX III DESCRIPTIVE STATISTICS OF SURFACE SEDIMENT TRACE METAL CONCENTRATIONS IN UG/G DRY WEIGHT (OCTOBER 1987)
- VANCOUVER HARBOUR (Continued)

Station	Statistic	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	V	Zn
40	MEAN(3)	27367	-	129.3	3.10	96.1	134	36600	0.475	11667	360	10	32	298	13	191.3	82	317
	S.D.	896	-	26.5	1.13	4.1	7	1300	0.019	58	8	0	3	58	5	82.8	3	27
	C.V.(%)	3	-	20	36	4	5	4	4	0	2	0	10	20	36	43	3	8
	MAX.	28400	<8	156.0	4.35	99.6	139	38100	0.488	11700	367	10	34	360	18	285.0	84	340
	MIN.	26800	<8	103.0	2.15	91.6	126	35800	0.454	11600	352	10	28	244	10	128.0	79	288
41A	MEAN(3)	29600	-	101.0	1.97	128.0	144	36767	0.331	12167	374	10	27	120	-	80.7	83	246
	S.D.	917	-	4.6	0.08	10.0	2	666	0.008	416	7	0	1	0	-	4.0	2	1
	C.V.(%)	3	-	4	4	8	2	2	2	3	2	0	4	0	-	5	2	0
	MAX.	30400	<8	105.0	2.04	138.0	147	37200	0.339	12500	380	10	28	120	<8	84.3	85	247
	MIN.	28600	<8	96.0	1.88	118.0	143	36000	0.323	11700	367	10	26	120	<8	76.4	81	245
41B	MEAN(3)	27800	9	91.1	5.80	111.7	135	35867	0.293	11900	362	9	27	110	-	77.3	76	244
	S.D.	600	1	3.4	6.76	3.5	3	702	0.014	265	9	1	2	0	-	3.3	1	7
	C.V.(%)	2	13	4	116	3	2	2	5	2	2	12	8	0	-	4	1	3
	MAX.	28400	10	94.7	13.60	115.0	138	36600	0.305	12200	371	10	29	110	<8	80.1	77	251
	MIN.	27200	<8	87.9	1.80	108.0	133	35200	0.277	11700	353	8	25	110	<8	73.6	76	237
41C	MEAN(3)	26933	-	89.9	1.66	78.2	131	36067	0.283	11900	361	9	27	86	-	73.5	77	209
	S.D.	757	-	2.7	0.14	0.2	3	1026	0.003	794	9	0	1	8	-	4.6	2	5
	C.V.(%)	3	-	3	9	0	2	3	1	7	2	0	2	9	-	6	3	2
	MAX.	27800	<8	93.0	1.78	78.3	133	37200	0.286	12800	371	9	27	93	<8	78.7	79	214
	MIN.	26400	<8	88.3	1.50	78.0	128	35200	0.280	11300	355	9	26	78	<8	70.0	75	205
41D	MEAN(3)	27200	9	91.7	1.84	69.7	146	36133	0.362	12400	368	10	28	83	9	75.6	79	202
	S.D.	700	1	1.8	0.41	3.9	37	1305	0.074	500	11	0	1	15	1	1.7	3	7
	C.V.(%)	3	13	2	23	6	25	4	20	4	3	0	2	18	13	2	4	3
	MAX.	28000	10	93.4	2.30	72.8	188	37500	0.436	12900	380	10	29	97	10	76.9	82	208
	MIN.	26700	<8	89.9	1.50	65.3	118	34900	0.288	11900	358	10	28	67	<8	73.7	76	195

APPENDIX III DESCRIPTIVE STATISTICS OF SURFACE SEDIMENT TRACE METAL CONCENTRATIONS IN UG/G DRY WEIGHT (OCTOBER 1987)
- VANCOUVER HARBOUR (Continued)

Station	Statistic	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	V	Zn
41E	MEAN(3)	27200	-	91.0	1.69	67.5	130	36233	0.319	11800	367	8	27	80	-	72.8	79	198
	S.D.	755	-	4.7	0.15	1.1	7	802	0.031	436	5	1	1	6	-	4.6	2	1
	C.V.(%)	3	-	5	9	2	6	2	10	4	1	7	4	7	-	6	3	0
	MAX.	28000	<8	95.9	1.86	68.7	135	37000	0.354	12300	371	9	28	84	<8	77.6	81	199
	MIN.	26500	<8	86.6	1.60	66.6	122	35400	0.294	11500	362	8	26	74	<8	68.4	77	197
41F	MEAN(3)	26667	-	92.3	1.69	62.9	125	35767	0.304	11400	356	8	26	78	-	74.4	78	201
	S.D.	1041	-	2.1	0.08	2.4	6	1250	0.060	700	14	2	2	3	-	2.2	4	5
	C.V.(%)	4	-	2	5	4	5	4	20	6	4	18	8	4	-	3	5	2
	MAX.	27500	<8	93.6	1.76	65.1	131	37000	0.373	12100	368	10	28	80	<8	76.4	81	204
	MIN.	25500	<8	89.9	1.60	60.3	119	34500	0.266	10700	341	7	24	74	<8	72.1	74	195
42A	MEAN(3)	26333	-	81.8	2.49	86.4	116	33533	0.274	11000	336	8	24	96	-	71.4	74	226
	S.D.	666	-	3.1	0.09	3.3	3	681	0.011	200	7	1	1	4	-	1.2	1	8
	C.V.(%)	2	-	4	4	4	2	2	4	2	2	7	2	4	-	2	2	3
	MAX.	26900	<8	85.4	2.59	89.5	119	34300	0.287	11200	342	9	25	100	<8	72.6	75	231
	MIN.	25600	<8	79.9	2.41	82.9	114	33000	0.266	10800	329	8	24	93	<8	70.3	73	217
42B	MEAN(3)	27833	-	92.1	4.31	67.6	105	35467	0.232	11800	361	9	25	62	-	74.1	74	194
	S.D.	1041	-	4.9	2.08	1.7	2	802	0.004	346	8	1	1	2	-	3.8	2	4
	C.V.(%)	4	-	5	48	3	2	2	2	3	2	11	2	4	-	5	3	2
	MAX.	29000	<8	97.6	6.16	69.5	107	36300	0.236	12200	367	10	25	65	<8	78.5	76	199
	MIN.	27000	<8	88.1	2.05	66.1	103	34700	0.229	11600	352	8	24	61	<8	71.7	72	191
42C	MEAN(3)	28067	-	92.9	1.95	52.7	73	36833	0.147	12967	399	9	29	26	-	73.8	78	138
	S.D.	1012	-	4.8	0.36	3.9	8	1721	0.021	208	11	0	1	7	-	5.2	3	23
	C.V.(%)	4	-	5	18	7	11	5	14	2	3	0	3	27	-	7	4	16
	MAX.	28700	<8	97.6	2.36	55.7	80	38200	0.170	13200	408	9	30	34	<8	79.8	80	162
	MIN.	26900	<8	88.1	1.70	48.3	64	34900	0.130	12800	386	9	28	20	<8	70.6	74	117

APPENDIX III DESCRIPTIVE STATISTICS OF SURFACE SEDIMENT TRACE METAL CONCENTRATIONS IN UG/G DRY WEIGHT (OCTOBER 1987) - VANCOUVER HARBOUR (Concluded)

Station	Statistic	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	V	Zn
45	MEAN(3)	24667	-	77.0	1.65	44.7	62	32033	0.109	11567	358	9	28	19	-	63.8	66	126
	S.D.	252	-	2.9	0.47	6.0	15	3927	0.018	666	27	1	6	8	-	1.6	8	22
	C.V.(%)	1	-	4	29	14	24	12	16	6	8	12	20	41	-	2	12	18
	MAX.	24900	<8	79.4	1.95	49.5	77	34400	0.130	12000	380	10	33	24	<8	65.1	71	150
	MIN.	24400	<8	73.7	1.10	37.9	47	27500	0.098	10800	328	8	22	10	<8	62.0	57	106
46	MEAN(3)	27433	-	88.4	2.87	64.4	107	36233	0.213	11900	376	10	29	64	-	72.5	73	250
	S.D.	1102	-	3.9	0.12	2.7	5	1234	0.022	265	14	0	1	5	-	1.8	3	17
	C.V.(%)	4	-	4	4	4	4	3	10	2	4	0	4	7	-	2	4	7
	MAX.	28500	<8	91.9	3.01	66.7	111	37600	0.238	12200	391	10	30	69	<8	74.2	75	269
	MIN.	26300	<8	84.2	2.77	61.4	102	35200	0.197	11700	363	10	28	60	<8	70.6	70	237
47A	MEAN(3)	29333	-	93.5	3.08	67.5	114	37333	0.198	12733	392	10	30	69	-	77.9	75	221
	S.D.	1250	-	4.7	0.21	2.2	3	1358	0.014	252	12	0	1	4	-	2.3	2	7
	C.V.(%)	4	-	5	7	3	3	4	7	2	3	0	4	6	-	3	3	3
	MAX.	30600	<8	98.1	3.32	69.9	118	38600	0.209	13000	403	10	31	74	<8	79.9	78	229
	MIN.	28100	<8	88.8	2.93	65.8	112	35900	0.183	12500	380	10	29	66	<8	75.4	74	216
LIA*	MEAN(3)	29067	-	119.0	0.56	33.8	62	34233	0.123	15300	2513	6	23	22	-	100	120	137
	S.D.	1914	-	7.8	0.08	1.9	9	1790	0.006	889	123	2	3	0.6	-	8	10	7
	C.V.(%)	7	-	7	14	6	14	5	5	6	5	33	12	3	-	8	8	6
	MAX.	31200	<8	128.0	0.65	35.9	72	36200	0.130	16300	2650	8	25	23	<8	109.0	130	135
	MIN.	27500	<8	113.0	0.51	32.2	56	32700	0.120	14600	2410	4	20	22	<8	93.5	110	121
LIB*	MEAN(3)	29033	-	96.2	0.31	38.4	65	29633	0.120	13833	559	3	21	22	-	94	100	103
	S.D.	451	-	1.2	0.01	0.4	1	289	0	231	12	0	4	1	-	2	0	1
	C.V.(%)	2	-	1	3	1	1	1	0	2	2	0	17	3	-	3	0	1
	MAX.	29500	<8	97.6	0.32	38.8	66	29800	0.120	14100	569	3	25	22	<8	96.7	100	104
	MIN.	28600	<8	95.2	0.30	38.0	65	29300	0.120	13700	546	3	18	21	<8	92.2	100	102

* LI - Loughborough Inlet, reference sites sampled in July 1987 (see Figure 1)

APPENDIX IV

TRACE METAL CONCENTRATIONS (μg/g DRY WEIGHT) IN STANDARD REFERENCE MATERIALS (MESS-1) AND PERCENTAGE RECOVERY BY EP LABORATORY FOR OCTOBER 1987 SAMPLES

APPENDIX IV TRACE METAL CONCENTRATIONS (UG/G DRY WEIGHT) IN STANDARD REFERENCE MATERIALS (MESS-1) AND PERCENTAGE RECOVERY BY EP LABORATORY FOR OCTOBER 1987 SAMPLES

MESS-1 (CERTIFIED(*) AND NON-CERTIFIED VALUES)

STATISTIC	Al	As*	Ba	Cd*	Cr*	Cu*	Fe	Hg*	Mg	Mn*	Mo	Ni	Pb*	Sn	Sr	V*	Zn*
MEAN	58000	10.6	270	.59	71	25.1	30500	.171	8680	513	2.2	29.5	34.0	6	89	72.4	191
±95% C.L.	2000	1.2	0	.10	11	3.8	1500	.014	542	25	0	2.7	6.1	0	0	5.3	17
LABORATORY RESULTS																	
	16800	<8	45.0	.72	29.7	29.9	25000	.252	6540	349	5	21	29	<8	29.6	38	172
	17200	<8	49.4	.76	31.4	31.1	26100	.206	6720	350	6	20	31	<8	31.1	40	188
	17700	<8	51.5	.81	32.7	28.6	26700	.228	6970	361	6	21	36	<8	32.5	40	185
MEAN	17233	-	48.6	.76	31.3	29.9	25933	.229	6743	353	6	21	32	-	31.1	39	182
% RECOVERY	30	-	18	129	44	119	85	134	78	69	258	70	94	-	35	54	95

APPENDIX V

SURFACE SEDIMENT ORGANIC COMPOUND CONCENTRATIONS IN UG/G DRY WEIGHT (OCTOBER 1987) - VANCOUVER HARBOUR

APPENDIX V SURFACE SEDIMENT ORGANIC COMPOUND CONCENTRATIONS IN UG/G DRY WEIGHT (OCTOBER 1987) - VANCOUVER HARBOUR

STATION	TRICHLOROPHENOLS					TETRACHLOROPHENOLS		PENTA-CHLORO-PHENOL	HYDRO-CARBONS	OILS + GREASE	POLYCHLORINATED BIPHENYLS			
											AROCLORS			
	2,3,4	2,3,5	2,3,6	2,4,5	2,4,6	2,3,4,5	2,3,4,6 + 2,3,5,6				1242	1254	1260	TOTAL
PEI	<.0005	<.0005	<.0005	<.0005	<.0005	.0007	.0007	.0001	252	252	<.01	<.01	.43	.43
	<.0005	<.0005	<.0005	<.0005	<.0005	<.0002	.0004	.0001	310	310	<.01	<.01	.36	.36
	<.0005	<.0005	<.0005	<.0005	<.0005	<.0002	<.0002	.0001	320	320	<.01	<.01	.26	.26
DD	<.0005	<.0005	<.0005	<.0005	<.0005	<.0002	<.0002	.0002	151	151	<.01	<.01	.37	.37
	<.0005	<.0005	<.0005	<.0005	<.0005	<.0002	<.0002	.0004	284	294	<.01	<.01	.41	.41
	<.0005	<.0005	<.0005	<.0005	<.0005	<.0002	<.0002	.0002	146	186	<.01	.10	<.01	.10
22A	<.0005	<.0005	.0010	<.0005	<.0005	.0021	.0016	<.0001	1343	1350	<.01	<.01	.13	.13
	<.0005	<.0005	.0007	<.0005	<.0005	.0029	.0005	<.0001	1110	1110	<.01	<.01	.04	.04
	<.0005	<.0005	.0005	<.0005	<.0005	.0010	.0011	<.0001	948	948	<.01	<.01	.10	.10
25A	<.0005	<.0005	.0013	<.0005	<.0005	<.0002	.0011	.0002	2900	3250	<.01	<.01	.09	.09
	<.0005	<.0005	.0029	<.0005	<.0005	.0030	.0004	<.0001	4920	5770	<.01	<.01	.11	.11
	<.0005	<.0005	.0008	<.0005	<.0005	<.0002	.0019	.0001	5580	5580	<.01	<.01	.10	.10
32	<.0005	<.0005	.0009	<.0005	<.0005	<.0002	.0003	.0003	902	953	<.01	<.01	.08	.08
	<.0005	<.0005	.0011	<.0005	<.0005	<.0002	.0005	<.0001	826	826	<.01	<.01	.04	.04
	<.0005	<.0005	.0007	<.0005	<.0005	<.0002	.0003	.0005	934	934	<.01	<.01	.03	.03
33B	<.0005	<.0005	.0008	<.0005	<.0005	<.0002	.0003	<.0001	779	779	<.01	.06	<.01	.06
	<.0005	<.0005	.0009	<.0005	<.0005	<.0002	.0003	<.0001	931	931	<.01	.11	<.01	.11
	<.0005	<.0005	.0011	<.0005	<.0005	<.0002	.0013	<.0001	677	957	<.01	<.01	.03	.03
34A	<.0005	<.0005	.0012	<.0005	<.0005	<.0002	.0006	<.0001	978	978	<.01	.08	<.01	.08
	<.0005	<.0005	.0013	<.0005	<.0005	.0002	.0006	<.0001	948	948	<.01	.08	<.01	.08
	<.0005	<.0005	.0012	<.0005	<.0005	<.0002	.0007	.0001	904	904	<.01	.07	<.01	.07

APPENDIX V   SURFACE SEDIMENT ORGANIC COMPOUND CONCENTRATIONS IN UG/G DRY WEIGHT (OCTOBER 1987) - VANCOUVER HARBOUR (Continued)

STATION	TRICHLOROPHENOLS					TETRACHLOROPHENOLS		PENTA-CHLORO-PHENOL	HYDRO-CARBONS	OILS + GREASE	POLYCHLORINATED BIPHENYLS			
											AROCLORS			
	2,3,4	2,3,5	2,3,6	2,4,5	2,4,6	2,3,4,5	2,3,4,6 + 2,3,5,6				1242	1254	1260	TOTAL
34B	<.0005	<.0005	.0008	<.0005	<.0005	.0008	.0003	<.0001	930	993	<.01	.07	<.01	.07
	<.0005	<.0005	.0008	<.0005	<.0005	.0006	.0002	.0004	1080	1080	<.01	.07	<.01	.07
	<.0005	<.0005	.0016	<.0005	<.0005	<.0002	.0008	<.0001	886	886	<.01	.09	<.01	.09
34C	<.0005	<.0005	.0009	<.0005	<.0005	.0005	.0003	.0002	852	926	<.01	.06	<.01	.06
	<.0005	<.0005	.0007	<.0005	<.0005	<.0002	.0004	.0005	1060	1100	<.01	<.01	.21	.21
	<.0005	<.0005	.0007	<.0005	<.0005	<.0002	.0002	<.0001	955	955	<.01	<.01	.06	.06
36A	<.0005	<.0005	.0014	<.0005	<.0005	<.0002	.0004	.0002	1080	1080	<.01	.07	<.01	.07
	<.0005	<.0005	.0016	<.0005	<.0005	<.0002	.0003	.0005	1103	1150	<.01	.08	<.01	.08
	<.0005	<.0005	.0013	<.0005	<.0005	<.0002	.0004	.0002	1140	1140	<.01	.08	<.01	.08
36B	<.0005	<.0005	<.0005	<.0005	<.0005	<.0002	.0004	.0004	969	969	<.01	<.01	.08	.08
	<.0005	<.0005	<.0005	<.0005	<.0005	<.0002	.0002	.0002	941	1150	<.01	<.01	.11	.11
	<.0005	<.0005	<.0005	<.0005	<.0005	<.0002	.0004	.0007	1200	1270	<.01	<.01	.07	.07
36C	<.0005	<.0005	.0013	<.0005	<.0005	<.0002	.0002	.0005	664	673	<.01	.03	<.01	.03
	<.0005	<.0005	.0014	<.0005	<.0005	<.0002	.0002	.0002	958	1310	<.01	.03	<.01	.03
	<.0005	<.0005	.0017	<.0005	<.0005	<.0002	.0003	.0002	1620	1620	<.01	.04	<.01	.04
36D	<.0005	<.0005	.0016	<.0005	<.0005	<.0002	.0003	.0004	1020	1020	<.01	<.01	.05	.05
	<.0005	<.0005	.0018	<.0005	<.0005	<.0002	.0003	.0006	972	972	<.01	<.01	.27	.27
	<.0005	<.0005	.0017	<.0005	<.0005	<.0002	<.0002	.0001	997	997	<.01	.05	<.01	.05
36E	<.0005	<.0005	.0018	<.0005	<.0005	<.0002	.0003	.0001	907	907	<.01	.06	<.01	.06
	<.0005	<.0005	.0017	<.0005	<.0005	<.0002	.0003	.0002	984	984	<.01	<.01	.04	.04
	<.0005	<.0005	.0017	<.0005	<.0005	<.0002	.0002	.0001	896	896	<.01	.05	<.01	.05
36F	<.0005	<.0005	.0016	<.0005	<.0005	<.0002	.0004	<.0001	980	980	<.01	.06	<.01	.06
	<.0005	<.0005	.0018	<.0005	<.0005	<.0002	.0003	.0004	900	900	<.01	.05	<.01	.05
	<.0005	<.0005	.0019	<.0005	<.0005	<.0002	.0003	.0003	789	789	<.01	.03	<.01	.03

APPENDIX V SURFACE SEDIMENT ORGANIC COMPOUND CONCENTRATIONS IN UG/G DRY WEIGHT (OCTOBER 1987) - VANCOUVER HARBOUR (Continued)

	TRICHLOROPHENOLS					TETRACHLOROPHENOLS		PENTA-			POLYCHLORINATED BIPHENYLS			
							2,3,4,6 +	CHLORO-	HYDRO-	OILS +	AROCLOR			
STATION	2,3,4	2,3,5	2,3,6	2,4,5	2,4,6	2,3,4,5	2,3,5,6	PHENOL	CARBONS	GREASE	1242	1254	1260	TOTAL
37A	<.0005	<.0005	<.0005	<.0005	<.0005	<.0002	.0005	.0001	1390	1390	<.01	<.01	.11	.11
	<.0005	<.0005	.0005	<.0005	<.0005	<.0002	.0003	.0004	1480	1480	<.01	<.01	.32	.32
	<.0005	<.0005	.0006	<.0005	.0006	<.0002	.0004	.0004	1160	1350	<.01	<.01	.10	.10
37B	<.0005	<.0005	.0005	<.0005	<.0005	<.0002	.0002	<.0001	1180	1270	.11	<.01	.10	.21
	<.0005	<.0005	.0007	<.0005	<.0005	<.0002	.0005	.0011	917	1070	<.01	<.01	.13	.13
	<.0005	<.0005	.0005	<.0005	<.0005	<.0002	.0005	<.0001	955	979	<.01	<.01	.13	.13
37C	<.0005	<.0005	.0011	<.0005	<.0005	<.0002	.0005	.0016	710	919	<.01	<.01	.13	.13
	<.0005	<.0005	.0006	<.0005	<.0005	<.0002	<.0002	<.0001	960	1060	<.01	<.01	.30	.30
	<.0005	<.0005	<.0005	<.0005	<.0005	<.0002	<.0002	<.0001	1110	1110	<.01	<.01	.05	.05
39A	<.005	<.005	<.005	<.005	<.005	<.002	<.002	<.001	2410	2410	<.01	<.01	.53	.53
	<.0005	<.0005	.0007	<.0005	<.0005	<.0002	.0006	.0010	2290	2340	<.01	<.01	.07	.07
	<.0005	<.0005	<.0005	<.0005	<.0005	<.0002	<.0002	.0002	2750	2920	<.01	<.01	.04	.04
39B	<.0005	<.0005	<.0005	<.0005	<.0005	<.0002	<.0002	<.0001	1620	1620	<.01	<.01	.40	.40
	<.005	<.005	<.005	<.005	<.005	<.002	<.002	<.001	1390	1390	<.01	<.01	.35	.35
	<.005	<.005	<.005	<.005	<.005	<.002	<.002	<.001	1400	1400	<.01	<.01	.46	.46
39C	<.0005	<.0005	.0005	<.0005	<.0005	<.0002	.0004	.0004	1330	1360	<.01	<.01	.04	.04
	<.0005	<.0005	.0006	<.0005	.0006	<.0002	.0005	.0008	1310	1310	<.01	<.01	.04	.04
	<.0005	<.0005	<.0005	<.0005	<.0005	<.0002	<.0002	<.0001	1180	1200	<.01	<.01	.60	.60
39D	<.0005	<.0005	.0007	<.0005	<.0005	<.0002	.0004	.0003	1250	1250	<.01	<.01	.03	.03
	<.0005	<.0005	.0007	<.0005	<.0005	<.0002	.0004	.0006	1300	1300	<.01	<.01	.04	.04
	<.0005	<.0005	.0006	<.0005	<.0005	<.0002	.0003	.0007	1250	1250	<.01	<.01	.04	.04
39E	<.0005	<.0005	<.0005	<.0005	<.0005	<.0002	<.0002	.0009	1260	1270	<.01	<.01	.04	.04
	<.0005	<.0005	<.0005	<.0005	<.0005	<.0002	<.0002	.0006	1180	1200	<.01	<.01	.04	.04
	<.0005	<.0005	<.0005	<.0005	<.0005	<.0002	<.0002	<.0001	1330	1350	<.01	<.01	.04	.04

APPENDIX V SURFACE SEDIMENT ORGANIC COMPOUND CONCENTRATIONS IN UG/G DRY WEIGHT (OCTOBER 1987) - VANCOUVER HARBOUR (Continued)

	TRICHLOROPHENOLS					TETRACHLOROPHENOLS					POLYCHLORINATED BIPHENYLS			
											AROCHLOR			
STATION	2,3,4	2,3,5	2,3,6	2,4,5	2,4,6	2,3,4,5	2,3,4,6 + 2,3,5,6	PENTA-CHLORO-PHENOL	HYDRO-CARBONS	OILS + GREASE	1242	1254	1260	TOTAL
40	<.0005	<.0005	.0006	<.0005	.0009	<.0002	.0005	.0006	2190	2260	<.01	<.01	.07	.07
	<.0005	<.0005	<.0005	<.0005	<.0005	<.0002	<.0002	.0005	1280	1280	<.01	<.01	.08	.08
	<.0005	<.0005	<.0005	<.0005	<.0005	<.0002	.0004	.0003	1580	1760	<.01	<.01	.08	.08
41A	<.0005	<.0005	.0011	<.0005	<.0005	<.0002	<.0002	.0003	1530	1890	<.01	<.01	.75	.75
	<.0005	<.0005	<.0005	<.0005	<.0005	<.0002	<.0002	<.0001	1920	2270	<.01	<.01	.11	.11
	<.0005	<.0005	.0005	<.0005	<.0005	<.0002	<.0002	.0019	2060	2140	<.01	<.01	.11	.11
41B	<.0005	<.0005	.0005	<.0005	<.0005	<.0002	<.0002	.0007	1520	1520	<.01	<.01	.12	.12
	<.0005	<.0005	.0005	<.0005	<.0005	<.0002	<.0002	.0007	1840	1860	<.01	<.01	.12	.12
	<.0005	<.0005	.0007	<.0005	<.0005	.0015	.0005	.0008	1760	1760	<.01	<.01	.07	.07
41C	<.0005	<.0005	.0006	<.0005	<.0005	.0012	.0004	.0008	1370	1370	<.01	<.01	.05	.05
	<.0005	<.0005	.0005	<.0005	<.0005	.0004	.0005	.0010	1030	1030	<.01	<.01	.05	.05
	<.0005	<.0005	.0018	<.0005	<.0005	<.0002	<.0002	.0006	1350	1350	<.01	.96	<.01	.96
41D	<.0005	<.0005	.0008	<.0005	<.0005	<.0002	<.0002	.0004	1150	1150	<.01	<.01	.17	.17
	<.0005	<.0005	.0022	<.0005	<.0005	<.0002	<.0002	.0010	1200	1200	<.01	<.01	.40	.40
	<.0005	<.0005	.0020	<.0005	<.0005	<.0002	<.0002	.0006	1200	1200	<.01	<.01	.02	.02
41E	<.0005	<.0005	.0022	<.0005	<.0005	<.0002	<.0002	.0009	1070	1070	<.01	<.01	.06	.06
	<.0005	<.0005	.0020	<.0005	<.0005	<.0002	<.0002	.0009	1300	1300	<.01	<.01	.06	.06
	<.0005	<.0005	.0021	<.0005	<.0005	<.0002	<.0002	.0009	1030	1030	<.01	<.01	.02	.02
41F	<.0005	<.0005	.0020	<.0005	<.0005	<.0002	<.0002	.0039	1060	1060	<.01	<.01	.69	.69
	<.0005	<.0005	.0015	<.0005	<.0005	<.0002	<.0002	<.0001	1050	1160	<.01	.20	<.01	.20
	<.0005	<.0005	.0017	<.0005	<.0005	<.0002	<.0002	<.0001	1270	1270	<.01	.07	<.01	.07
42A	<.0005	<.0005	.0023	<.0005	<.0005	<.0002	<.0002	<.0001	1560	1560	<.01	.08	<.01	.08
	<.0005	<.0005	.0035	<.0005	<.0005	<.0002	.0009	.0006	1610	1610	<.01	<.01	.04	.04
	<.0005	<.0005	.0034	<.0005	<.0005	<.0002	.0008	.0005	1760	1760	<.01	<.01	.03	.03

APPENDIX V SURFACE SEDIMENT ORGANIC COMPOUND CONCENTRATIONS IN UG/G DRY WEIGHT (OCTOBER 1987) - VANCOUVER HARBOUR (Concluded)

	TRICHLOROPHENOLS					TETRACHLOROPHENOLS		PENTA-CHLORO-PHENOL	HYDRO-CARBONS	OILS + GREASE	POLYCHLORINATED BIPHENYLS			
											ARCHLORS			
STATION	2,3,4	2,3,5	2,3,6	2,4,5	2,4,6	2,3,4,5	2,3,4,6 + 2,3,5,6				1242	1254	1260	TOTAL
42B	<.0005	<.0005	.0027	<.0005	<.0005	<.0002	<.0002	<.0001	878	878	<.01	<.01	.05	.05
	<.0005	<.0005	.0021	<.0005	<.0005	<.0002	<.0002	<.0001	1190	1190	<.01	.08	<.01	.08
	<.0005	<.0005	.0020	<.0005	<.0005	<.0002	<.0002	<.0001	960	960	<.01	.07	<.01	.07
42C	<.0005	<.0005	.0015	<.0005	<.0005	<.0002	<.0002	<.0001	563	628	<.01	.03	<.01	.03
	<.0005	<.0005	.0036	<.0005	<.0005	<.0002	<.0002	<.0001	419	482	<.01	.03	<.01	.03
	<.0005	<.0005	.0017	<.0005	<.0005	<.0002	<.0002	<.0001	506	534	<.01	<.01	.02	.02
45	<.0005	<.0005	.0030	<.0005	<.0005	<.0002	.0006	.0004	741	741	<.01	<.01	.05	.05
	<.0005	<.0005	.0020	<.0005	<.0005	<.0002	.0002	<.0001	293	293	<.01	<.01	.01	.01
	<.0005	<.0005	.0027	<.0005	<.0005	<.0002	.0009	<.0001	1040	1040	<.01	<.01	.16	.16
46	<.0005	<.0005	.0022	<.0005	<.0005	<.0002	.0014	.0006	1390	1390	<.01	.10	<.01	.10
	<.0005	<.0005	.0020	<.0005	<.0005	<.0002	.0013	.0006	1380	1380	<.01	.10	<.01	.10
	<.0005	<.0005	.0021	<.0005	<.0005	<.0002	.0012	.0013	1330	1330	<.01	.08	<.01	.08
47A	<.0005	<.0005	.0015	<.0005	<.0005	<.0002	.0007	.0012	1330	1330	<.01	.06	<.01	.06
	<.0005	<.0005	.0016	<.0005	<.0005	<.0002	.0010	.0006	1400	1400	<.01	<.01	.28	.28
	<.0005	<.0005	.0022	<.0005	<.0005	<.0002	.0006	<.0001	745	855	<.01	.04	<.01	.04
LIA*	<.0005	<.0005	<.0005	<.0005	<.0005	<.0002	<.0002	<.0001	70	70	<.01	.05	<.01	.05
	<.0005	<.0005	<.0005	<.0005	<.0005	<.0002	<.0002	<.0001	57	57	<.01	.02	<.01	.02
	<.0005	<.0005	<.0005	<.0005	<.0005	<.0002	<.0002	<.0001	70	70	<.01	.05	<.01	.05

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* LI - Loughborough Inlet, reference station sampled July 1987 (See Figure 1)

APPENDIX VI

DESCRIPTIVE STATISTICS OF SURFACE SEDIMENT ORGANIC COMPOUND CONCENTRATIONS IN UG/G DRY WEIGHT (OCTOBER 1987) - VANCOUVER HARBOUR

APPENDIX VI DESCRIPTIVE STATISTICS OF SURFACE SEDIMENT ORGANIC COMPOUND CONCENTRATIONS IN UG/G DRY WEIGHT (OCTOBER 1987) - VANCOUVER HARBOUR

Station	Statistic	Oils and Grease	Hydro-carbons	Poly-chlorinated Biphenyls (PCB)	Penta-chloro-phenols (PCP)
PEI	MEAN(3)	294	294	0.35	0.0001
	S.D.	37	37	0.09	0
	C.V(%)	12	12	24	0
	MAX.	320	320	0.43	0.0001
	MIN.	252	252	0.26	0.0001
DD	MEAN(3)	210	194	0.29	0.0003
	S.D.	75	78	0.17	0.0001
	C.V(%)	35	40	57	43
	MAX.	294	284	0.41	0.0004
	MIN.	151	146	0.10	0.0002
22A	MEAN(3)	1136	1134	0.09	-
	S.D.	202	199	0.05	-
	C.V(%)	18	18	51	-
	MAX.	1350	1343	0.13	<0.0001
	MIN.	948	948	0.04	<0.0001
25A	MEAN(3)	4867	4467	0.10	0.0001
	S.D	1403	1396	0.01	0.0001
	C.V(%)	29	31	10	43
	MAX.	5770	5580	0.11	0.0002
	MIN.	3250	2900	0.09	<0.0001
32	MEAN(3)	904	887	0.05	0.0003
	S.D.	69	55	0.03	0.0002
	C.V(%)	8	6	53	67
	MAX.	953	934	0.08	0.0005
	MIN.	826	826	0.03	<0.0001
33B	MEAN(3)	889	796	0.07	-
	S.D.	96	128	0.04	-
	C.V(%)	11	16	61	-
	MAX.	957	931	0.11	<0.0001
	MIN.	779	677	0.03	<0.0001
34A	MEAN(3)	943	943	0.08	0.0001
	S.D.	37	37	0.01	0
	C.V(%)	4	4	8	0
	MAX.	978	978	0.08	0.0001
	MIN.	904	904	0.07	<0.0001
34B	MEAN(3)	986	965	0.08	0.0002
	S.D.	97	102	0.01	0.0002
	C.V(%)	10	11	15	87
	MAX.	1080	1080	0.09	0.0004
	MIN.	886	886	0.07	<0.0001
34C	MEAN(3)	994	956	0.11	0.0003
	S.D.	93	104	0.09	0.0002
	C.V(%)	9	11	82	78
	MAX.	1100	1060	0.21	0.0005
	MIN.	926	852	0.06	<0.0001
36A	MEAN(3)	1123	1108	0.08	0.0003
	S.D.	38	30	0.01	0.0002
	C.V(%)	3	3	8	58
	MAX.	1150	1140	0.08	0.0005
	MIN.	1080	1080	0.07	0.0002

APPENDIX VI DESCRIPTIVE STATISTICS OF SURFACE SEDIMENT ORGANIC COMPOUND CONCENTRATIONS IN UG/G DRY WEIGHT (OCTOBER 1987) - VANCOUVER HARBOUR (CONTINUED)

Station	Statistic	Oils and Grease	Hydro-carbons	Poly-chlorinated Biphenyls (PCB)	Penta-chloro-phenols (PCP)	Station	Statistic	Oils and Grease	Hydro-carbons	Poly-chlorinated Biphenyls (PCB)	Penta-chloro-phenols (PCP)
36B	MEAN(3)	1130	1037	0.09	0.0004	37A	MEAN(3)	1407	1343	0.18	0.0003
	S.D.	152	142	0.02	0.0003		S.D.	67	165	0.12	0.0002
	C.V(%)	13	14	24	58		C.V(%)	5	12	70	58
	MAX.	1270	1200	0.11	0.0007		MAX.	1480	1480	0.32	0.0004
	MIN.	969	941	0.07	0.0002		MIN.	1350	1160	0.10	0.0001
36C	MEAN(3)	1201	1081	0.03	0.0003	37B	MEAN(3)	1106	1017	0.16	0.0004
	S.D.	483	490	0.01	0.0002		S.D.	149	142	0.05	0.0006
	C.V(%)	40	45	17	58		C.V(%)	13	14	29	133
	MAX.	1620	1620	0.04	0.0005		MAX.	1270	1180	0.21	0.0011
	MIN.	673	664	0.03	0.0002		MIN.	979	917	0.13	<0.0001
36D	MEAN(3)	996	996	0.12	0.0004	37C	MEAN(3)	1030	927	0.16	0.0006
	S.D.	24	24	0.13	0.0003		S.D.	99	202	0.13	0.0009
	C.V(%)	2	2	103	69		C.V(%)	10	22	80	144
	MAX.	1020	1020	0.27	0.0006		MAX.	1110	1110	0.30	0.0016
	MIN.	972	972	0.05	0.0001		MIN.	919	710	0.05	<0.0001
36E	MEAN(3)	929	929	0.05	0.0001	39A	MEAN(3)	2557	2483	0.21	0.0007
	S.D.	48	48	0.01	0.0001		S.D.	317	239	0.27	0.0005
	C.V(%)	5	5	20	43		C.V(%)	12	10	129	63
	MAX.	984	984	0.06	0.0002		MAX.	2920	2750	0.53	0.0010
	MIN.	896	896	0.04	0.0001		MIN.	2340	2290	0.04	0.0002
36F	MEAN(3)	890	890	0.05	0.0003	39B	MEAN(3)	1470	1470	0.40	-
	S.D.	96	96	0.02	0.0002		S.D.	130	130	0.06	-
	C.V(%)	11	11	33	57		C.V(%)	9	9	14	-
	MAX.	980	980	0.06	0.0004		MAX.	1620	1620	0.46	<0.0010
	MIN.	789	789	0.03	<0.0001		MIN.	1390	1390	0.35	<0.0001

APPENDIX VI DESCRIPTIVE STATISTICS OF SURFACE SEDIMENT ORGANIC COMPOUND CONCENTRATIONS IN UG/G DRY WEIGHT (OCTOBER 1987) - VANCOUVER HARBOUR (CONTINUED)

Station	Statistic	Oils and Grease	Hydro-carbons	Poly-chlorinated Biphenyls (PCB)	Penta-chloro-phenols (PCP)
39C	MEAN(3)	1290	1273	0.23	0.0004
	S.D.	82	81	0.32	0.0004
	C.V(%)	6	6	143	81
	MAX.	1360	1330	0.60	0.0008
	MIN.	1200	1180	0.04	<0.0001
39D	MEAN(3)	1267	1267	0.04	0.0005
	S.D.	29	29	0.01	0.0002
	C.V(%)	2	2	16	39
	MAX.	1300	1300	0.04	0.0007
	MIN.	1250	1250	0.03	0.0003
39E	MEAN(3)	1273	1257	0.04	0.0005
	S.D.	75	75	0	0.0004
	C.V(%)	6	6	0	76
	MAX.	1350	1330	0.04	0.0009
	MIN.	1200	1180	0.04	<0.0001
40	MEAN(3)	1767	1683	0.08	0.0005
	S.D.	490	464	0.01	0.0002
	C.V(%)	28	28	8	33
	MAX.	2260	2190	0.08	0.0006
	MIN.	1280	1280	0.07	0.0003
41A	MEAN(3)	2100	1837	0.32	0.0008
	S.D.	193	275	0.37	0.0010
	C.V(%)	9	15	114	129
	MAX.	2270	2060	0.75	0.0019
	MIN.	1890	1530	0.11	<0.0001
41B	MEAN(3)	1713	1707	0.10	0.0007
	S.D.	175	167	0.03	0.0001
	C.V(%)	10	10	28	8
	MAX.	1860	1840	0.12	0.0008
	MIN.	1520	1520	0.07	0.0007
41C	MEAN(3)	1250	1250	0.35	0.0008
	S.D.	191	191	0.53	0.0002
	C.V(%)	15	15	149	25
	MAX.	1370	1370	0.96	0.0010
	MIN.	1030	1030	0.05	0.0006
41D	MEAN(3)	1183	1183	0.20	0.0007
	S.D.	29	29	0.19	0.0003
	C.V(%)	2	2	97	46
	MAX.	1200	1200	0.40	0.0010
	MIN.	1150	1150	0.02	0.0004
41E	MEAN(3)	1133	1133	0.05	0.0009
	S.D.	146	146	0.02	0
	C.V(%)	13	13	49	0
	MAX.	1300	1300	0.06	0.0009
	MIN.	1030	1030	0.02	0.0009
41F	MEAN(3)	1163	1127	0.32	0.0014
	S.D.	105	124	0.33	0.0022
	C.V(%)	9	11	102	161
	MAX.	1270	1270	0.69	0.0039
	MIN.	1060	1050	0.07	<0.0001

APPENDIX VI DESCRIPTIVE STATISTICS OF SURFACE SEDIMENT ORGANIC COMPOUND CONCENTRATIONS IN UG/G DRY WEIGHT (OCTOBER 1987) - VANCOUVER HARBOUR (CONCLUDED)

Station	Statistic	Oils and Grease	Hydro-carbons	Poly-chlorinated Biphenyls (PCB)	Penta-chloro-phenols (PCP)
42A	MEAN(3)	1643	1643	0.05	0.0004
	S.D.	104	104	0.03	0.0003
	C.V(%)	6	6	53	66
	MAX.	1760	1760	0.08	0.0006
	MIN.	1560	1560	0.03	<0.0001
42B	MEAN(3)	1009	1009	0.07	-
	S.D.	162	162	0.02	-
	C.V(%)	16	16	23	-
	MAX.	1190	1190	0.08	<0.0001
	MIN.	878	878	0.05	<0.0001
42C	MEAN(3)	548	496	0.03	-
	S.D.	74	73	0.01	-
	C.V(%)	14	15	22	-
	MAX.	628	563	0.03	<0.0001
	MIN.	482	419	0.02	<0.0001
45	MEAN(3)	691	691	0.07	0.0002
	S.D.	376	376	0.08	0.0002
	C.V(%)	54	54	106	87
	MAX.	1040	1040	0.16	0.0004
	MIN.	293	293	0.01	<0.0001
46	MEAN(3)	1367	1367	0.09	0.0008
	S.D.	32	32	0.01	0.0004
	C.V(%)	2	2	12	48
	MAX.	1390	1390	0.10	0.0013
	MIN.	1330	1330	0.08	0.0006
47A	MEAN(3)	1195	1158	0.13	0.0006
	S.D.	297	360	0.13	0.0006
	C.V(%)	25	31	105	87
	MAX.	1400	1400	0.28	0.0012
	MIN.	855	745	0.04	<0.0001
LIA*	MEAN(3)	66	66	0.04	-
	S.D.	8	8	0.02	-
	C.V(%)	11	11	43	-
	MAX.	70	70	0.05	<0.0001
	MIN.	57	57	0.02	<0.0001

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* LI - Loughborough Inlet, reference site sampled in July 1987 (See Figure 1)

APPENDIX VII

SEDIMENT POLYCYCLIC AROMATIC HYDROCARBON (PAH) CONCENTRATIONS UG/G DRY WEIGHT VANCOUVER HARBOUR - OCTOBER 1987

APPENDIX VII SEDIMENT POLYCYCLIC AROMATIC HYDROCARBON (PAH) CONCENTRATIONS IN UG/G DRY WEIGHT - VANCOUVER HARBOUR - OCTOBER 1987

Station/	PEI					EB***			15	16	19
Replicates	#1	2A	2B	#2*	X**	1A	1B	#1*	#1	#1	#1
Low Molecular Weight PAH											
Naphthalene	0.11	0.09	0.10	0.10	0.10	0.20	0.35	0.28	0.12	0.17	0.24
Acenaphthylene	<0.01	<0.01	<0.01	<0.01	<0.01	0.07	0.06	0.06	0.01	0.03	0.03
Acenaphthene	0.01	0.01	0.01	0.01	0.01	0.02	0.03	0.02	0.03	0.05	0.06
Anthracene	0.03	0.04	0.04	0.04	0.04	0.11	0.08	0.10	0.07	0.11	0.16
Phenanthrene	0.12	0.15	0.14	0.14	0.13	0.28	0.24	0.26	0.30	0.39	0.50
Fluorene	0.03	0.03	0.03	0.03	0.03	0.07	0.07	0.07	0.06	0.08	0.11
Total Low Molecular Weight PAH					0.31			0.79	0.59	0.83	1.10
High Molecular Weight PAH											
Fluoranthene	0.21	0.23	0.20	0.22	0.22	0.48	0.30	0.39	0.32	0.53	0.64
Pyrene	0.23	0.24	0.22	0.23	0.23	0.76	0.51	0.64	0.33	0.74	0.69
Chrysene	0.21	0.24	0.27	0.26	0.24	0.58	0.30	0.44	0.28	0.38	0.59
Benzo(a)anthracene	0.12	0.14	0.13	0.14	0.13	0.40	0.20	0.30	0.15	0.22	0.31
Benzo(b)fluoranthene + Benzo(k)fluoranthene	0.21	0.21	0.29	0.25	0.23	0.48	0.30	0.39	0.28	0.30	0.51
Benzo(a)pyrene	0.12	0.14	0.15	0.14	0.13	0.43	0.25	0.34	0.14	0.19	0.27
Benzo(g,h,i)perylene	0.08	0.08	0.13	0.10	0.09	0.22	0.16	0.19	0.09	0.11	0.17
Dibenzo(a,h)anthracene	0.01	0.01	0.02	0.02	0.02	0.04	0.04	0.04	0.04	0.02	0.06
Benzo(e)pyrene	0.11	0.14	0.14	0.14	0.12	0.28	0.17	0.22	0.13	0.17	0.25
Indeno(1,2,3-cd)pyrene	0.02	-	0.05	0.05	0.04	0.10	0.08	0.09	0.06	0.04	0.10
Total High Molecular Weight PAH					1.45			3.04	1.82	2.70	3.59
Total PAH					1.76			3.83	2.41	3.53	4.69

* Mean of internal laboratory duplicates A & B

** Mean of #1 & #2 (less than values set equal to detection limit to calculate means except when all replicates are below detection then less than value not included in PAH totals)

*** EB - English Bay site sampled in October 1988

APPENDIX VII SEDIMENT POLYCYCLIC AROMATIC HYDROCARBON (PAH) CONCENTRATIONS IN UG/G DRY WEIGHT - VANCOUVER HARBOUR OCTOBER 1987 (CONTINUED)

Station/	22A			25A			33B			36A
Replicates	#1	#2	X**	#1	#2	X**	#1	#2	X**	#1
Low Molecular Weight PAH										
Naphthalene	0.69	0.33	0.51	0.52	0.72	0.62	0.37	0.29	0.33	0.39
Acenaphthylene	0.05	0.03	0.04	0.09	0.04	0.06	0.06	0.04	0.05	0.07
Acenaphthene	0.19	0.12	0.16	0.27	0.24	0.26	0.05	0.05	0.05	0.04
Anthracene	0.38	0.26	0.32	0.67	0.27	0.47	0.09	0.30	0.20	0.09
Phenanthrene	1.09	0.92	1.00	2.04	1.15	1.60	0.40	0.42	0.41	0.39
Fluorene	0.30	0.21	0.26	0.39	0.37	0.38	0.09	0.09	0.09	0.09
Total Low Molecular Weight PAH			2.29			3.39			1.13	1.07
High Molecular Weight PAH										
Fluoranthene	1.53	1.34	1.44	3.30	1.83	2.56	0.48	0.46	0.47	0.40
Pyrene	1.91	1.49	1.70	2.82	1.61	2.22	0.56	0.48	0.52	0.48
Chrysene	1.62	1.35	1.48	2.85	1.70	2.28	0.51	0.43	0.47	0.39
Benzo(a)anthracene	0.84	0.72	0.78	1.66	0.68	1.17	0.24	0.21	0.22	0.19
Benzo(b)fluoranthene + Benzo(k)fluoranthene	1.69	1.63	1.66	2.63	1.49	2.06	0.60	0.49	0.54	0.49
Benzo(a)pyrene	0.87	0.86	0.86	1.57	0.73	1.15	0.33	0.27	0.30	0.28
Benzo(g,h,i)perylene	0.72	0.71	0.72	1.28	0.55	0.92	0.31	0.22	0.26	0.26
Dibenzo(a,h)anthracene	0.12	0.21	0.16	0.34	0.18	0.26	0.10	0.07	0.08	0.07
Benzo(e)pyrene	0.74	0.72	0.73	1.13	0.69	0.91	0.32	0.24	0.28	0.28
Indeno(1,2,3-cd)pyrene	0.40	0.39	0.40	0.68	0.31	0.50	0.16	0.12	0.14	0.13
Total High Molecular Weight PAH			9.93			14.03			3.28	2.97
Total PAH			12.22			17.42			4.41	4.04

** Mean of #1 & #2 (less than values set equal to detection limit to calculate means except when all replicates are below detection then less than value not included in PAH totals)

APPENDIX VII SEDIMENT POLYCYCLIC AROMATIC HYDROCARBON (PAH) CONCENTRATIONS IN UG/G DRY WEIGHT - VANCOUVER HARBOUR OCTOBER 1987 (CONTINUED)

Station/	36B			36C			37A	39A				
Replicates	#1	#2	X**	1A	1B	#1*	#1	#1	2A	2B	#2*	X**
Low Molecular Weight PAH												
Naphthalene	0.49	0.24	0.36	0.59	0.72	0.66	0.61	0.55	0.72	0.84	0.78	0.66
Acenaphthylene	0.11	0.06	0.08	0.08	0.09	0.08	0.13	0.09	0.17	0.19	0.18	0.14
Acenaphthene	0.06	0.03	0.04	0.50	0.46	0.48	0.05	0.06	0.05	0.07	0.06	0.06
Anthracene	0.13	0.09	0.11	0.50	0.44	0.47	0.12	0.17	0.19	0.19	0.19	0.18
Phenanthrene	0.50	0.40	0.45	3.58	2.68	3.13	0.52	0.59	0.67	0.69	0.68	0.64
Fluorene	0.12	0.07	0.10	0.86	0.78	0.82	0.10	0.13	0.10	0.11	0.10	0.12
Total Low Molecular Weight PAH			1.14			5.64	1.53					1.80
High Molecular Weight PAH												
Fluoranthene	0.41	0.62	0.52	3.83	2.84	3.34	0.70	0.65	0.87	0.69	0.78	0.72
Pyrene	0.50	0.77	0.64	2.75	2.19	2.47	0.92	1.01	1.52	1.15	1.34	1.18
Chrysene	0.41	0.69	0.55	1.91	1.46	1.68	0.66	0.75	0.78	0.37	0.58	0.66
Benzo(a)anthracene	0.19	0.32	0.26	0.95	0.90	0.92	0.28	0.29	0.31	0.16	0.24	0.26
Benzo(b)fluoranthene + Benzo(k)fluoranthene	0.44	0.94	0.69	1.22	1.31	1.26	0.88	1.03	1.52	0.64	1.08	1.06
Benzo(a)pyrene	0.26	0.56	0.41	0.64	0.66	0.65	0.54	0.56	1.06	0.41	0.74	0.65
Benzo(g,h,i)perylene	0.24	0.67	0.46	0.40	0.46	0.43	0.86	0.73	1.92	0.74	1.33	1.03
Dibenzo(a,h)anthracene	0.06	0.07	0.06	0.04	0.06	0.05	0.07	0.11	0.27	0.02	0.14	0.12
Benzo(e)pyrene	0.26	0.56	0.41	0.54	0.58	0.56	0.57	0.64	1.01	0.43	0.72	0.68
Indeno(1,2,3-cd)pyrene	0.11	0.32	0.22	0.16	0.22	0.19	0.30	0.30	0.75	0.29	0.52	0.41
Total High Molecular Weight PAH			4.22			11.55	5.78					6.77
Total PAH			5.36			17.19	7.31					8.57

* Mean of internal laboratory duplicates A & B

** Mean of #1 & #2 (less than values set equal to detection limit to calculate means except when all replicates are below detection then less than value not included in PAH totals).

APPENDIX VII SEDIMENT POLYCYCLIC AROMATIC HYDROCARBON (PAH) CONCENTRATIONS IN UG/G DRY WEIGHT - VANCOUVER HARBOUR OCTOBER 1987 (CONTINUED)

Station/	39C					39E			40		
Replicates	#1	2A	2B	#2*	X**	#1	#2	X**	#1	#2	X**
Low Molecular Weight PAH											
Naphthalene	0.63	0.55	0.60	0.58	0.60	0.52	0.66	0.59	0.62	0.78	0.70
Acenaphthylene	0.16	0.15	0.16	0.16	0.16	0.12	0.14	0.13	0.10	0.11	0.10
Acenaphthene	0.07	0.05	0.05	0.05	0.06	0.15	0.32	0.24	0.13	0.18	0.16
Anthracene	0.13	0.13	0.14	0.14	0.14	0.51	1.22	0.86	0.46	0.99	0.72
Phenanthrene	0.55	0.52	0.51	0.52	0.54	1.56	3.16	2.40	0.82	1.27	1.04
Fluorene	0.10	0.10	0.10	0.10	0.10	0.33	0.74	0.54	0.21	0.27	0.24
Total Low Molecular Weight PAH					1.60			4.76			2.96
High Molecular Weight PAH											
Fluoranthene	0.62	0.62	0.72	0.67	0.64	3.48	7.78	5.63	1.19	2.60	1.90
Pyrene	0.83	0.84	1.01	0.92	0.88	3.84	7.26	5.55	4.04	5.20	4.62
Chrysene	0.41	0.51	0.62	0.56	0.48	4.20	8.35	6.28	2.16	2.51	2.34
Benzo(a)anthracene	0.18	0.21	0.26	0.24	0.21	2.16	4.49	3.32	0.61	0.83	0.72
Benzo(b)fluoranthene + Benzo(k)fluoranthene	0.53	0.66	0.85	0.76	0.64	3.53	5.50	4.52	2.88	3.09	2.98
Benzo(a)pyrene	0.32	0.39	0.50	0.44	0.38	1.88	2.95	2.42	1.56	1.98	1.77
Benzo(ghi)perylene	0.45	0.50	0.74	0.62	0.54	1.16	1.36	1.26	1.45	1.54	1.50
Dibenzo(ah)anthracene	0.06	0.07	0.09	0.08	0.07	0.38	0.49	0.44	0.35	0.54	0.44
Benzo(e)pyrene	0.35	0.42	0.56	0.49	0.42	1.51	2.07	1.79	1.64	1.98	1.81
Indeno(1,2,3-cd)pyrene	0.18	0.21	0.30	0.26	0.22	0.68	0.83	0.76	0.73	0.76	0.74
Total High Molecular Weight PAH					4.48			31.97			18.82
Total PAH					6.08			36.73			21.78

* Mean of internal laboratory duplicates A & B

** Mean of #1 & #2 (less than values set equal to detection limit to calculate means except when all replicates are below detection then less than value not included in PAH totals)

APPENDIX VII SEDIMENT POLYCYCLIC AROMATIC HYDROCARBON (PAH) CONCENTRATIONS IN UG/G DRY WEIGHT - VANCOUVER HARBOUR OCTOBER 1987 (CONTINUED)

Station/ Replicates	41A					41B			41D		
	1A	1B	#1*	#2	X**	#1	#2	X**	#1	#2	X**
Low Molecular Weight PAH											
Naphthalene	0.42	0.42	0.42	0.58	0.50	0.30	0.34	0.32	0.59	0.56	0.58
Acenaphthylene	0.07	0.07	0.07	0.08	0.08	0.06	0.08	0.07	0.14	0.15	0.14
Acenaphthene	0.06	0.06	0.06	0.06	0.06	0.04	0.04	0.04	0.04	0.05	0.04
Anthracene	0.18	0.18	0.18	0.18	0.18	0.13	0.14	0.14	0.11	0.13	0.12
Phenanthrene	0.49	0.48	0.48	0.54	0.51	0.50	0.52	0.51	0.49	0.56	0.52
Fluorene	0.12	0.11	0.12	0.13	0.12	0.10	0.12	0.11	0.10	0.11	0.10
Total Low Molecular Weight PAH					1.45			1.19			1.50
High Molecular Weight PAH											
Fluoranthene	0.59	0.61	0.60	0.74	0.67	0.66	0.62	0.64	0.54	0.65	0.60
Pyrene	-	0.94	0.94	1.18	1.06	0.94	0.87	0.90	0.76	0.87	0.82
Chrysene	0.91	0.93	0.92	0.99	0.96	0.71	0.61	0.66	0.45	0.47	0.46
Benzo(a)anthracene	0.31	0.29	0.30	0.36	0.33	0.27	0.22	0.24	0.19	0.19	0.19
Benzo(b)fluoranthene + Benzo(k)fluoranthene	0.94	0.92	0.93	1.31	1.12	0.92	0.78	0.85	0.62	0.53	0.58
Benzo(a)pyrene	0.48	0.46	0.47	0.68	0.58	0.50	0.45	0.48	0.36	0.28	0.32
Benzo(g,h,i)perylene	0.45	0.32	0.38	0.83	0.60	0.67	0.57	0.62	0.56	0.34	0.45
Dibenzo(a,h)anthracene	0.14	0.70	0.42	0.19	0.30	0.14	0.12	0.13	0.08	0.07	0.08
Benzo(e)pyrene	0.56	0.54	0.55	0.80	0.68	0.61	0.52	0.56	0.40	0.32	0.36
Indeno(1,2,3-cd)pyrene	0.18	0.17	0.18	0.38	0.28	0.29	0.24	0.26	0.24	0.14	0.19
Total High Molecular Weight PAH					6.58			5.34			4.05
Total PAH					8.03			6.53			5.55

* Mean of internal laboratory duplicates A & B

** Mean of #1 & #2 (less than values set equal to detection limit to calculate means except when all replicates are below detection then less than value not included in PAH totals).

APPENDIX VII SEDIMENT POLYCYCLIC AROMATIC HYDROCARBON (PAH) CONCENTRATIONS IN UG/G DRY WEIGHT - VANCOUVER HARBOUR - OCTOBER 1987 (CONCLUDED)

Station/ Replicates	42A #1	42B #1	42C #1	47A #1
Low Molecular Weight PAH				
Naphthalene	0.65	0.40	0.30	0.29
Acenaphthylene	0.12	0.06	0.04	0.04
Acenaphthene	0.06	0.04	0.07	0.04
Anthracene	0.12	0.09	0.10	0.09
Phenanthrene	0.56	0.46	0.49	0.50
Fluorene	0.12	0.09	0.09	0.10
Total Low Molecular Weight PAH	1.63	1.14	1.09	1.06
High Molecular Weight PAH				
Fluoranthene	0.56	0.65	0.62	0.57
Pyrene	0.72	0.71	0.62	0.60
Chrysene	0.43	0.50	0.43	0.47
Benzo(a)anthracene	0.16	0.19	0.24	0.20
Benzo(b)fluoranthene + Benzo(k)fluoranthene	0.44	0.58	0.56	0.50
Benzo(a)pyrene	0.24	0.29	0.29	0.26
Benzo(g,h,i)perylene	0.25	0.42	0.36	0.30
Dibenzo(a,h)anthracene	0.06	0.04	0.02	0.06
Benzo(e)pyrene	0.28	0.33	0.27	0.31
Indeno(1,2,3-cd)pyrene	0.09	0.17	0.16	0.13
Total High Molecular Weight PAH	3.23	3.88	3.57	3.40
Total PAH	4.86	5.02	4.66	4.46

APPENDIX D

VANCOUVER HARBOUR BENTHIC ENVIRONMENTAL QUALITY STUDIES

MAY 1985 - SEPTEMBER 1986

SEDIMENT PARTICLE SIZE DISTRIBUTION, RESIDUE, AND BACTERIA CONTENT

By

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D. GOYETTE

OCTOBER 1989

REVIEW NOTICE

Data reports are prepared to make data available without full analysis or interpretation. This report has been reviewed by the Marine Programs Division, Environmental Protection, and approved for limited distribution. For further information please contact:

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TABLE OF CONTENTS

PAGE

REVIEW NOTICE i
TABLE OF CONTENTS ii
List of Figures iii
List of Tables iii
1.0 **INTRODUCTION** 1
2.0 **MATERIAL AND METHODS** 2
2.1 Study Area 2
2.2 Field Collection 2
2.3 Laboratory Analysis 7
3.0 RESULTS 8
3.1 Particle Size Distribution 8
3.2 Sediment Residue Analysis 8
3.3 Bacteria Content 8
REFERENCES 14
ACKNOWLEDGEMENTS 15
APPENDIX I Vancouver Harbour Sampling Station Coordinates and Depths (1985-86) 16
APPENDIX II Sediment Volatile Residue (SVR) and Sediment Fixed Residue (SFR) Concentrations in Vancouver Harbour (1985-86) 20

LIST OF FIGURES

PAGE

Figure 1 Sediment Sampling Stations in Vancouver Harbour (1985-86):
(a) Outer and Inner Harbour 3
(b) Central and Eastern Harbour 4

Figure 2 Mean Sediment Volatile Residue (SVR) in Vancouver Harbour (1985-86) 12

LIST OF TABLES

PAGE

Table 1 Vancouver Harbour Sediment Sampling Stations for Particle Size and Residue Analyses in 1985-86 5

Table 2 Sediment Particle Size Distribution in Vancouver Harbour (1985 - 1986) 9

Table 3 Seasonal Variation in Mean Sediment Residue Concentrations (μg/g dry weight) for Selected Stations in Vancouver Harbour (1985-86) 13

Table 4 Sediment Bacteria Content at Selected Stations in Vancouver Harbour - June 1986 (MPN/100 g) 13

1.0 INTRODUCTION

Environment Canada began a series of environmental quality studies in Vancouver Harbour in May of 1985 following an impact assessment by Waters (1985a,b). Emphasis was placed on sampling surface bottom sediments and benthic epifauna to evaluate selected trace metal (Thomas and Goyette, 1989a; Thomas and Goyette, 1989b) and organic chemicals (Thomas and Goyette, 1989c; Thomas and Goyette, 1989d). Species abundance and distribution have been reported (Goyette and Thomas, 1987) in addition to tissue abnormalities in flatfish (Goyette et al., 1988).

This report documents sediment characteristics including particle size, residue (volatile and fixed), and bacteria content in Vancouver Harbour. Particle size is a measure of sediment texture. In general, the finer the grain, the increased tendency for sediment contamination because of the larger surface area. Bacteria content (coliform, fecal coliforms, and fecal streptococci) and volatile residue analysis estimate environmental quality by the extent of bacterial contamination and organic matter present, respectively. Domestic sewage discharge, pulp mills, farm runoff, fish and food packaging plants are among potential sources which influence these parameters.

2.0 MATERIALS AND METHODS

2.1 Study Area

Vancouver Harbour was subdivided into four hydrographic regions from west to east (Point Atikinson to the head of Port Moody Arm); stations are indicated in bracket.

OUTER HARBOUR - Point Atkinson (ATK)
- Pacific Environment Institute (PEI)
- Spanish Banks (SB)
- Dundarave (DD)

INNER HARBOUR - North Shore (Stations 1 to 13B)
- Centre (14 to 16)
- South Shore (Stations 17 to 31)

CENTRAL HARBOUR - Cates Park (CP)
- Boulder Rock (BR)

EASTERN HARBOUR - Port Moody Arm Stations (32 to 47)

The sampling stations are located in Figure 1a (outer and inner harbour) and figure 1b (central harbour and Port Moody Arm). The station coordinates and depths are provided in Appendix I. Using the research vessel, CSS Vector, 6 surveys were conducted from 1985 to 1986 to collect the samples. A schedule is provided in Table 1 for particle size and residue collections. The sediment sampling for bacterial analysis was conducted in June 1986 along the south shore of the inner harbour near combined sewer overflow and storm water discharges (Stations 20A, 20B, 21A, 21C, 22A, 22C, 24, 25A, 25C, 26, 27, 28 and 30).

2.2 Field Collections

Sediment was obtained with a 0.1 square meter stainless steel Smith-MacIntyre grab to provide a undisturbed sample of the bottom surface. The top two centimeters were scooped into heavy kraft paper bags then frozen until analyzed for particle size and residue. For bacteriological analysis, samples were removed using sterile plastic disposeable spoons and stored at 4-10°C in sterile "whirlpak" bags.

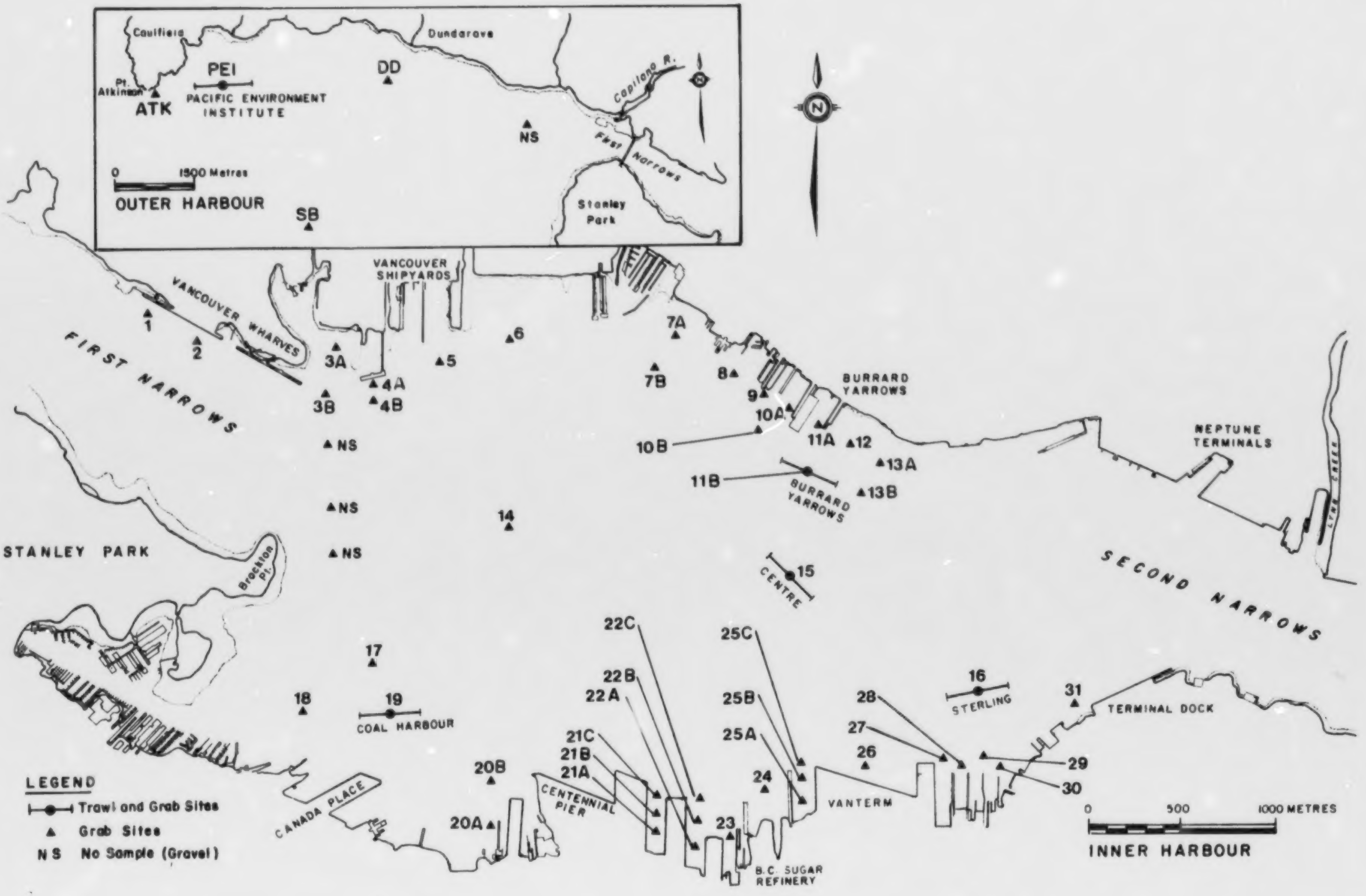
Caulfield
Pt. Atkinson
ATK
PEI
PACIFIC ENVIRONMENT INSTITUTE
Dundarave
DD
NS
Capilano R.
First Narrows
Stanley Park
SB
0
1500 Metres
OUTER HARBOUR
N
VANCOUVER WHARVES
VANCOUVER SHIPYARDS
FIRST NARROWS
1
2
3A
3B
4A
4B
5
6
7A
7B
8
9
10A
10B
11A
11B
12
13A
13B
14
15
CENTRE
16
STERLING
17
18
19
COAL HARBOUR
20A
20B
21A
21B
21C
22A
22B
22C
23
24
25A
25B
25C
26
27
28
29
30
31
NS
NS
NS
BURRARD YARROWS
BURRARD YARROWS
NEPTUNE TERMINALS
LYNN CREEK
SECOND NARROWS
TERMINAL DOCK
VANTERM
B.C. SUGAR REFINERY
CENTENNIAL PIER
CANADA PLACE
Brockton Pt.
STANLEY PARK
0
500
1000 METRES
INNER HARBOUR
LEGEND
Trawl and Grab Sites
Grab Sites
NS No Sample (Gravel)

FIGURE 1a SEDIMENT SAMPLING STATIONS IN VANCOUVER HARBOUR (1985-86)
- OUTER AND INNER HARBOUR

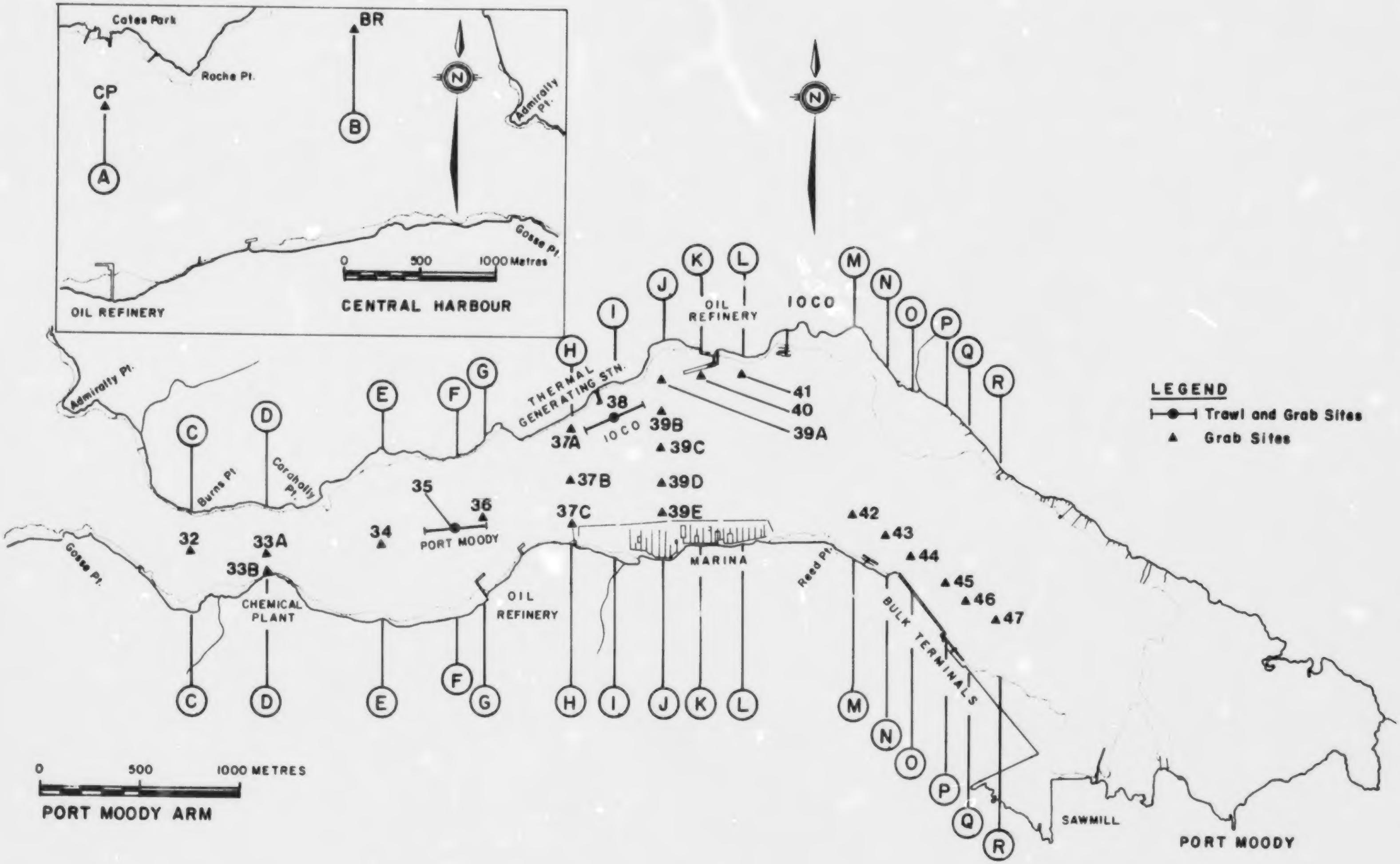
Cates Park
Roche Pt.
CP
A
BR
B
N
Admiralty Pt.
Gosse Pt.
0 500 1000 Metres
OIL REFINERY
CENTRAL HARBOUR
Admiralty Pt.
Burns Pt.
Caraholly Pt.
C
D
E
F
G
H
I
J
K
L
M
N
O
P
Q
R
THERMAL GENERATING STN.
OIL REFINERY
IOCO
38
IOCO
37A
39B
39C
37B
39D
37C
39E
41
40
39A
35
36
PORT MOODY
34
32
33A
33B
CHEMICAL PLANT
OIL REFINERY
MARINA
Reed Pt.
42
43
44
45
46
47
BULK TERMINALS
SAWMILL
PORT MOODY
LEGEND
Trawl and Grab Sites
Grab Sites
0 500 1000 METRES
PORT MOODY ARM

FIGURE 1b SEDIMENT SAMPLING STATIONS IN VANCOUVER HARBOUR (1985-86) - CENTRAL HARBOUR AND PORT MOODY ARM

TABLE 1 VANCOUVER HARBOUR SEDIMENT SAMPLING STATIONS FOR PARTICLE SIZE AND RESIDUE ANALYSES IN 1985-86.

AREA	STN	TOTAL NUMBER SURVEYS	MAY 1985	OCT 1985	NOV 1985	JAN 1986	MAY 1986	JUNE 1986	SEPT 1986
OUTER HARBOUR									
	SB		x̲						
	ATK	1							_
	PEI	5	x̲	x̲		x̲	x̲		x̲
	DD			x̲					
INNER HARBOUR									
North Shore	1	1						x̲	
	2	1						x̲	
	3A	1							x̲
	3B	1							x̲
	4A	1			x̲				
	4B	1							_
	5	1			x̲				
	6	1			x̲				
	7A	1			x̲				
	7B	1			x̲				
	8	1			x̲				
	9	1			x̲				
	10A	1			x̲				
	10B	1			x̲				
	11A	1			x̲				
	11B	5	x̲	x̲		x̲	x̲		x̲
	12	1			x̲				
	13A	1			x̲				
	13B	1			x̲				
Centre	14	1							x
	15	2				x	x		
	16	4	x̲	x̲			x̲		x̲
South Shore	17	1							
	18	1				x̲			
	19	5	x̲	x̲		x̲	x̲		_
	20A	1						x̲	
	20B	1						x̲	
	21A	1						x̲	
	21B	1						x̲	
	21C	1						x̲	
	22A	1						x̲	
	22B	1						x̲	
	22C	1						x̲	

x - particle size analysis   _ - residue analysis   x̲ - both analyses

TABLE 1 VANCOUVER HARBOUR SEDIMENT SAMPLING STATIONS FOR PARTICLE SIZE AND RESIDUE ANALYSES IN 1985-86 (CONTINUED).

AREA	STN	TOTAL NUMBER SURVEYS	MAY 1985	OCT 1985	NOV 1985	JAN 1986	MAY 1986	JUNE 1986	SEPT 1986
	23	1						x̲	
	24	1						x̲	
	25A	1						x̲	
	25B	1						x̲	
	25C	1						x̲	
	26	1						x̲	
	27	1						x̲	
	28	1						x̲	
	29	1						x̲	
	30	1						x̲	
	31	1						x̲	
CENTRAL HARBOUR	CP	1	x						
	BR	1	x						
EASTERN HARBOUR PT.MOODY ARM	32		x̲						
	33A		x̲						
	33B		x̲						
	34		x̲						
	35	5	x̲	x̲		x̲	x̲		_
	36	1			x				
	37A	1			x̲				
	37B	1			x̲				
	37C	1			x̲				
	38	3				x̲	x̲		_
	39A	1			x̲				
	39B	1			x̲				
	39C	1			x̲				
	39D	1			x̲				
	39E	1			x̲				
	40	1			x̲				
	41	1			x̲				
	42								
	43	1	x						
	44	1	x						
	45	1	x						
	46	1	x						
	47	1	x						

x - particle size analysis _ - residue analysis x̲ - both analyses

Triplicate grabs were routinely taken at each site for residue analysis, however, only one sample per site was analyzed for particle size. The sites located at the centre of the trawl sites (i.e. benthic epifauna and demersal fish study sites, see Appendix I), were sampled on three to five occasions for particle size and residue to assess seasonal variability. Samples were also taken for trace metal and organic compound (i.e. oil and greases, hydrocarbons, chlorophenols, and polycyclic aromatic hydrocarbons) analyses and have reported (Thomas and Goyette, 1989a; Thomas and Goyette, 1989b).

2.3 Laboratory Analysis

Particle Size: For particle size determination, each sample was dried, then passed through a series of sieves with decreasing mesh sizes for grain separation as follows.

silt and clay = <0.063mm (-230 mesh)
very fine sand = 0.063 - 0.125mm (230 mesh)
fine sand = 0.125 - 0.25mm (120 mesh)
medium sand = 0.25 - 0.50mm (60 mesh)
coarse sand = 0.50 - 1.00mm (35 mesh)
very coarse sand = 1.00 - 2.00mm (18 mesh)
granules = >2.00 mm (10 mesh)

The amount collected in each sieve was weighed and the percent composition of the total weight calculated to determine particle size distribution.

Residue: For sediment residue analysis, the sample is oven dried then ignited at 550°C in a muffle furnace. The loss of weight on ignition represents the sediment volatile residue (SVR), and the remaining residue represents the sediment fixed residue (SFR). Volatile residue is only a rough measure of the organics because results may also reflect loss of water at crystallization, loss of volatile organic matter before combustion, incomplete oxidation, and decompostion of mineral salts during combustion. For a detailed description of the residue analysis, refer to APHA (1985) or Swingle and Davidson (1979).

Bacteria Content: For bacteriological analysis, approximately 50 - 100 grams of sediment sample was weighed into a sterile wide-mouth jar. The sediment was diluted 1:10 (by weight) with sterile phosphate buffered dilution water and shaken as per Part 900 of Standard Methods (APHA, 1985). Duplicate analysis of the 1:10 dilution was performed using the Most Probable Number (MPN) enumeration techniques for total confirmed coliform, fecal coliform, and fecal streptococci as described in Parts 908A, 908C, and 910A, respectively (APHA, 1985). Sample results were expressed as MPN per 100g.

3.0 RESULTS

3.1 Particle Size Distribution

The distribution of particle size throughout the harbour is presented in Table 2. The outer harbour (PEI, SB) is predominantly silt and clay becoming coarser toward the first narrows (DD). In the inner harbour, sediment texture averaged very fine to fine grain along the north shore. It was fine in the centre of the harbour then varied from silt and clay to medium sand on the south shore. Cates Park (CP) and Boulder Rock (BR) in the central harbour were very fine to fine. Sediments in Port Moody Arm are primarily fine to medium near the mouth of the arm becoming coarser toward the centre.

3.2 Sediment Residue Analysis

Sediment volatile residue mean concentrations Vancouver Harbour are represented graphically in Figure 2. Mean values of volatile and fixed residue in sediment for stations which were repeated for seasonal comparison are presented in Table 3. Refer to Appendix II for raw data values.

3.3 Bacteria Content

Sediment total coliform, fecal coliform, and fecal streptococci counts are given in Table 4 for the 13 sites sampled. The highest values occurred at Station 25A, near a combined sewer overflow.

TABLE 2 SEDIMENT PARTICLE SIZE DISTRIBUTION IN VANCOUVER HARBOUR (1985 - 1986)

Station	Median Particle Size	silt and clay (%)	very fine sand (%)	fine sand (%)	medium sand (%)	coarse sand (%)	very coarse sand (%)	granules (%)
SB	silt and clay	61	11	11	11	4	2	0
PEI-M85	silt and clay	51	9	12	13	8	6	1
-O85	silt and clay	71	11	15	3	0	0	0
-J86	silt and clay	57	8	10	16	9	0	0
-M86	silt and clay	76	5	6	9	4	trace	0
-S86	silt and clay	84	3	3	2	2	2	4
DD	coarse sand	16	4	12	15	13	9	31
1	fine sand	15	11	37	25	5	2	5
2	medium sand	8	6	30	31	13	6	6
3A	medium sand	24	8	10	11	7	8	32
4A	fine sand	13	15	51	13	5	2	1
5	silt and clay	50	14	7	7	8	6	8
6	very fine sand	38	23	15	9	8	4	3
7A	very fine sand	36	21	13	14	11	5	trace
7B	very fine sand	34	20	11	10	9	9	7
8	very fine sand	31	31	18	10	7	3	trace
9	very fine sand	37	23	15	9	7	4	5
10A	fine sand	20	22	22	16	13	6	1
10B	fine sand	29	20	25	12	9	4	1
11A	fine sand	18	26	29	9	5	3	10
11B-M85	fine sand	5	13	70	7	2	2	1
-O85	fine sand	3	8	69	17	1	1	1
-J86	fine sand	18	24	39	11	4	1	3
-M86	very fine sand	28	24	35	6	3	2	2
-S86	fine sand	18	20	49	7	2	2	2
12	fine sand	22	15	30	20	7	3	3
13A	medium sand	8	7	31	29	12	7	6
13B	fine sand	7	8	61	20	2	2	2
14	fine sand	26	23	22	10	5	3	11
15-J86	fine sand	28	21	14	14	14	2	7
-M86	very fine sand	38	32	19	6	3	1	1

TABLE 7 SEDIMENT PARTICLE SIZE DISTRIBUTION IN VANCOUVER HARBOUR (1985 - 1986)

Station	Median Particle Size	silt and clay (%)	very fine sand (%)	fine sand (%)	medium sand (%)	coarse sand (%)	very coarse sand (%)	granules (%)
16-M85	fine sand	5	13	70	7	2	2	1
-O85	very fine sand	31	32	25	9	1	trace	2
-M86	very fine sand	36	31	21	6	4	1	1
-S86	very fine sand	26	32	29	7	4	1	1
17	very fine sand	43	30	15	6	2	1	3
18	fine sand	25	18	25	20	10	1	1
19-M85	silt and clay	61	13	9	8	6	2	1
-O85	very fine sand	33	27	21	14	3	1	1
-J86	very fine sand	28	24	21	16	7	1	3
-M86	very fine sand	47	28	11	8	4	1	1
20A	silt and clay	84	5	3	4	3	1	trace
20B	very fine sand	42	22	18	8	6	2	2
21A	medium sand	15	7	19	22	8	6	23
21B	medium sand	16	11	31	31	7	2	2
21C	fine sand	25	12	20	26	10	4	3
22A	silt and clay	55	21	13	6	4	1	trace
22B	very fine sand	39	21	19	11	5	2	3
22C	very fine sand	40	16	13	11	9	8	3
23	fine sand	29	20	27	13	6	2	3
24	coarse sand	13	7	10	13	10	10	37
25A	fine sand	20	16	30	16	9	6	3
25B	fine sand	16	28	29	13	8	3	3
25C	medium sand	21	13	15	9	8	8	26
26	very fine sand	29	30	21	10	6	3	1
27	medium sand	26	11	12	17	15	9	10
28	medium sand	18	16	15	16	11	4	20
29	fine sand	25	24	19	14	7	4	7
30	very fine sand	29	32	21	7	4	2	5
31	fine sand	9	13	32	11	5	7	23
CP	fine sand	2	7	45	13	15	14	4
BR	very fine sand	38	34	15	7	5	1	trace

TABLE 7 SEDIMENT PARTICLE SIZE DISTRIBUTION IN VANCOUVER HARBOUR (1985 - 1986)

Station	Median Particle Size	silt and clay (%)	very fine sand (%)	fine sand (%)	medium sand (%)	coarse sand (%)	very coarse sand (%)	granules (%)
32	fine sand	40	8	8	14	15	14	1
33A	fine sand	31	11	12	13	16	12	5
33B	very fine sand	41	11	10	13	13	9	3
34	medium sand	34	6	8	15	18	18	1
35 -M85	medium sand	31	6	10	13	15	20	5
-085	very fine sand	49	8	10	12	9	6	6
-J86	medium sand	30	9	11	21	21	6	2
-M86	fine sand	40	6	8	13	14	13	6
36	medium sand	37	4	6	10	10	14	19
37A	fine sand	42	5	5	7	10	15	16
37B	medium sand	33	6	7	12	15	20	7
37C	medium sand	31	8	10	14	15	15	7
38 -J86	medium sand	27	7	11	19	22	13	1
-M86	fine sand	43	5	8	12	14	12	6
39A	coarse sand	20	5	6	9	12	19	29
39B	coarse sand	30	5	6	9	12	20	18
39C	coarse sand	25	5	7	12	16	22	13
39D	fine sand	42	5	7	7	14	14	7
39E	coarse sand	25	6	7	12	15	20	15
40	coarse sand	26	4	7	11	15	19	18
41	very coarse sand	19	4	6	11	9	14	37
43	very coarse sand	26	5	6	12	18	24	9
44	coarse sand	25	4	8	12	17	25	9
45	medium sand	37	5	7	11	13	18	9
46	medium sand	30	6	10	12	14	23	5
47	fine sand	37	7	10	10	9	15	12

silt and clay = <0.063 mm
very fine sand = 0.063-0.125 mm
fine sand = 0.125-0.25 mm
medium sand = 0.25-0.50 mm
coarse sand = 0.50-1.00 mm
very coarse sand = 1.00-2.00 mm
granules = >2.00 mm

SB = Spanish Banks
DD = Dundarave
CP = Cates Park
BR = Boulder Rock

M85 = MAY 1985
085 = OCTOBER 1985
J86 = JANUARY 1986
M86 = MAY 1986
S86 = SEPTEMBER 1986

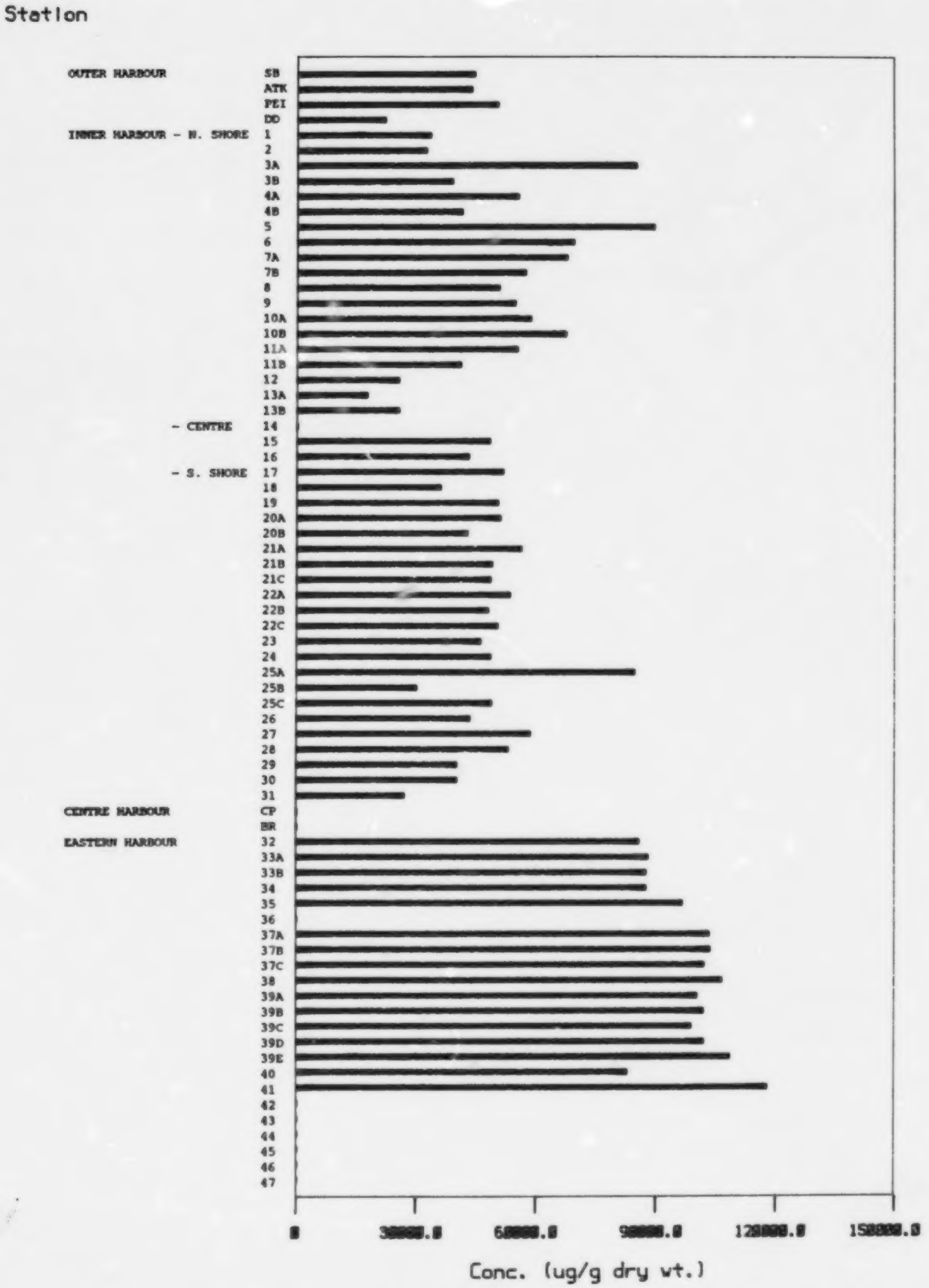

FIGURE 2 Mean Surface Sediment Volatile Residue (SVR) in Vancouver Harbour (1985-86)

TABLE 3. SEASONAL VARIATION IN MEAN SEDIMENT RESIDUE CONCENTRATIONS (UG/G DRY WEIGHT BETWEEN FIELD SURVEYS IN VANCOUVER HARBOUR (1985-1986)

Station	Survey Date	SVR	SFR	Station	Survey	SVR	SFR
PEI	May 85	56767	923667	19	May 85	36000	964000
	Oct 85	55467	944333		Oct 85	47300	938667
	Jan 86	43367	956667		Jan 86	51767	948333
	May 86	52567	947333		May 86	52833	914000
	Sep 86	43667	956333		Sep 86	46200	954000
11	May 85	29367	968333	35	May 85	87133	1036000
	Oct 85	51967	915000		Oct 85	101833	898333
	Jan 86	64433	935667		Jan 86	89200	911000
	May 86	36933	951000		May 86	105667	894333
	Sep 86	23033	977000		Sep 86	99933	900000
15	Jan 86	48767	951333	38	Jan 86	104000	896000
	May 86	38133	961667		May 86	113667	886333
	Sep 86	58100	942000		Sep 86	100433	899667
16	May 85	55567	932333				
	Oct 85	51367	949333				
	May 86	40700	959333				
	Sep 86	25867	972667				

TABLE 4 SEDIMENT BACTERIA CONTENT AT SELECTED STATIONS IN VANCOUVER HARBOUR - JUNE 1987 (MPN/100 G)

Station	Total Coliform	Fecal Coliform	Fecal Streptococci
20A	17 000	2 800	53 000
20B	17 000	2 000	15 000
21A	56 000	22 000	62 500
21C	88 000	13 000	104 500
22A	110 000	22 000	109 500
22C	67 000	15 950	74 500
24	28 000	3 300	144 500
25A	>2 400 000	>2 400 000	>2 400 000
25C	51 000	12 000	35 000
26	190 000	15 450	51 500
27	285 000	2 800	105 000
28	195 000	13 150	185 000
30	100 000	28 000	89 500

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APPENDIX I

VANCOUVER HARBOUR SAMPLING STATION COORDINATES AND DEPTHS

1985 - 1986

APPENDIX I VANCOUVER HARBOUR SAMPLING STATION COORDINATES AND DEPTHS (1985-86)

AREA	STATION	SURVEY	LATITUDE	LONGITUDE	DEPTH(m)
OUTER HARBOUR					
	SB	May 85	49°18.23'N	123°13.78'W	55
	ATK	Sep 86	49°19.67'N	123°15.80'W	60
	PEI (Trawl)	May 85	49°19.80'N	123°13.73'W	59
		Oct 85	49°19.75'N	123°13.95'W	68
		Jan 86	49°19.55'N	123°13.92'W	67
		May 86	49°19.77'N	123°13.90'W	60
		Sep 86	49°19.80'N	123°13.94'W	58
	DD	Oct 85	49°19.70'N	123°11.65'W	25
INNER HARBOUR					
North Shore	1	Jun 86	49°18.72'N	123°07.45'W	13
	2	Jun 86	49°18.65'N	123°07.27'W	12
	3A	Sep 86	49°18.73'N	123°06.62'W	12
	3B	Sep 86	49°18.48'N	123°06.67'W	14
	4A	Nov 85	49°18.50'N	123°06.48'W	20
	4B	Sep 86	49°18.40'N	123°06.50'W	21
	5	Nov 85	49°18.58'N	123°06.21'W	24
	6	Nov 85	49°18.62'N	123°05.90'W	27
	7A	Nov 85	49°18.63'N	123°05.15'W	20
	7B	Nov 85	49°18.53'N	123°05.25'W	27
	8	Nov 85	49°18.52'N	123°04.89'W	16
	9	Nov 85	49°18.45'N	123°04.76'W	20
	10A	Nov 85	49°18.39'N	123°04.70'W	22
	10B	Nov 85	49°18.35'N	123°04.50'W	28
	11A	Nov 85	49°18.35'N	123°04.53'W	20
	11B (Trawl)	May 85	49°18.12'N	123°04.45'W	21
		Oct 85	49°18.10'N	123°04.40'W	23
		Jan 86	49°18.27'N	123°04.88'W	26
		May 86	49°18.30'N	123°04.88'W	28
		Sep 26	49°18.37'N	123°04.87'W	24
	12	Nov 85	49°18.27'N	123°04.39'W	24
	13A	Nov 85	49°18.23'N	123°04.27'W	24
	13B	Nov 85	49°18.26'N	123°04.18'W	26
Centre	14	Sep 86	49°18.10'N	123°05.83'W	25
	15 (Trawl)	Jan 86	49°18.01'N	123°05.07'W	43
		May 86	49°17.61'N	123°04.60'W	30
		Sep 86	49°17.95'N	123°05.00'W	18
	16 (Trawl)	May 85	49°17.60'N	123°03.87'W	21
		Oct 85	49°17.60'N	123°03.80'W	29
		May 86	49°17.60'N	123°03.87'W	20
		Sep 86	49°17.63'N	123°03.73'W	19

APPENDIX I VANCOUVER HARBOUR SAMPLING STATION COORDINATES AND DEPTHS (1985-86) (CONTINUED)

AREA	STATION	SURVEY	LATITUDE	LONGITUDE	DEPTH(m)
South Shore	17	Sep 86	49°17.70'N	123°06.50'W	17
	18	Jan 86	49°17.41'N	123°06.65'W	14
	19 (Trawl)	May 85	49°17.47'N	123°06.15'W	18
		Oct 85	49°17.29'N	123°06.17'W	18
		Jan 86	49°17.47'N	123°06.30'W	18
		May 86	49°17.47'N	123°06.15'W	20
		Sep 86	49°17.48'N	123°06.28'W	19
	20A	Jun 86	49°17.22'N	123°05.99'W	14
	20B	Jun 86	49°17.35'N	123°05.99'W	18
	21A	Jun 86	49°17.16'N	123°05.77'W	14
	21B	Jun 86	49°17.23'N	123°05.77'W	20
	21C	Jun 86	49°17.30'N	123°05.77'W	28
	22A	Jun 86	49°17.15'N	123°05.08'W	13
	22B	Jun 86	49°17.20'N	123°05.08'W	18
	22C	Jun 86	49°17.28'N	123°05.08'W	28
	23	Jun 86	49°17.20'N	123°04.94'W	19
	24	Jun 86	49°17.32'N	123°04.78'W	22
	25A	Jun 86	49°17.28'N	123°04.54'W	32
	25B	Jun 86	49°17.33'N	123°04.54'W	29
	25C	Jun 86	49°17.38'N	123°04.54'W	26
	26	Jun 86	49°17.37'N	123°04.33'W	26
	27	Jun 86	49°17.41'N	123°03.99'W	14
	28	Jun 86	49°17.36'N	123°03.84'W	17
	29	Jun 86	49°17.41'N	123°03.81'W	21
	30	Jun 86	49°17.37'N	123°03.73'W	13
	31	Jun 86	49°17.60'N	123°03.40'W	29
CENTRAL HARBOUR					
	CP	May 85	49°17.95'N	122°57.78'W	28
	BR	May 85	49°18.20'N	122°56.36'W	32
EASTERN HARBOUR					
Port Moody Arm	32	May 85	49°17.49'N	122°55.00'W	20
	33A	May 85	49°17.47'N	122°54.66'W	22
	33B	May 85	49°17.49'N	122°54.70'W	32
	34	May 85	49°17.49'N	122°54.25'W	17
	35 (Trawl)	May 85	49°17.61'N	122°53.83'W	17
		Oct 85	49°17.62'N	122°53.78'W	15
		Jan 86	49°17.61'N	122°53.81'W	18
		May 86	49°17.64'N	122°53.80'W	18
		Sep 86	49°17.61'N	122°53.85'W	16
	36	Nov 85	49°17.70'N	122°53.70'W	17
	37A	Nov 85	49°17.83'N	122°53.40'W	15
	37B	Nov 85	49°17.70'N	122°53.43'W	15
	37C	Nov 85	49°17.56'N	122°53.42'W	15

APPENDIX I VANCOUVER HARBOUR SAMPLING STATION COORDINATES AND DEPTHS (1985-86)

AREA	STATION	SURVEY	LATITUDE	LONGITUDE	DEPTH(m)
	38	Jan 86	49°17.95'N	122°53.10'W	12
		May 86	49°17.95'N	122°53.15'W	14
		Sep 86	49°17.91'N	122°53.10'W	15
	39A	Nov 85	49°18.00'N	122°53.02'W	10
	39B	May 85	49°17.90'N	122°53.02'W	12
	39C	Nov 85	49°17.80'N	122°53.02'W	12
	39D	Nov 85	49°17.70'N	122°53.02'W	13
	39E	Nov 85	49°17.60'N	122°53.02'W	13
	40	Nov 85	49°17.95'N	122°52.90'W	12
	41	Nov 85	49°17.95'N	122°52.70'W	8
	42	May 85	49°17.61'N	122°52.23'W	13
	43	May 85	49°17.56'N	122°52.11'W	13
	44	May 85	49°17.50'N	122°51.98'W	14
	45	May 85	49°17.45'N	122°51.85'W	14
	46	May 85	49°17.39'N	122°51.73'W	14
	47	May 85	49°17.35'N	122°51.60'W	11

Note: (Trawl) denotes sediment sampling stations corresponding to otter trawl sampling sites (biota sampling).

APPENDIX II

SEDIMENT VOLATILE AND FIXED RESIDUE CONCENTRATIONS IN VANCOUVER HARBOUR (1985 - 1986)

APPENDIX II SEDIMENT VOLATILE AND FIXED RESIDUE CONCENTRATIONS IN VANCOUVER HARBOUR (1985 - 1986)

STATION	CONCENTRATION (ug/g)			
	MEAN	MEAN	REPLICATES	
	SVR	SFR	SVR	SFR
SPANISH BANKS	44600	940667	41900	942000
			44000	942000
			47900	938000
POINT ATKINSON	43867	956000	42100	958000
			44800	955000
			44700	955000
DUNDARAVE	22067	978000	27500	972000
			28500	972000
			10200	990000
PEI MAY85	56767	923667	57500	927000
			57800	916000
			55000	928000
OCT85	55467	944333	54600	945000
			56100	944000
			55700	944000
JAN86	43367	956667	45700	954000
			43300	957000
			41100	959000
MAY86	52567	947333	54100	946000
			53600	946000
			50000	950000
SEPT86	43667	956333	43500	957000
			43600	956000
			43900	956000
1	33467	966667	42100	952000
			10300	958000
			48000	990000
2	32367	967667	45300	955000
			30000	970000
			21800	978000
3A	85067	915000	87500	913000
			83600	916000
			84100	916000
3B	39000	961000	42800	957000
			35800	964000
			38400	962000
20A	51000	949000	51400	949000
			50600	949000
			51000	949000
20B	42667	957333	43700	957000
			41000	959000
			43300	956000
21A	56233	943667	54800	946000
			59600	940000
			54300	945000
21B	48900	951333	41800	958000
			50400	946000
			54500	950000
21C	48600	951333	48100	952000
			50800	949000
			46900	953000
22A	53433	946667	52200	948000
			56500	948000
			51600	944000
22B	47967	952000	45600	954000
			52000	948000
			46300	954000
22C	50267	950000	52100	948000
			48200	952000
			50500	95000
23	46067	954000	49200	951000
			47000	953000
			4	958000
24	48600	951333	51600	948000
			48200	952000
			46000	954000
25A	84533	915667	96900	903000
			59300	941000
			97400	903000
25B	30100	970000	32400	968000
			25700	974000
			32200	968000

APPENDIX II SEDIMENT VOLATILE AND FIXED RESIDUE CONCENTRATIONS IN VANCOUVER HARBOUR (1985 - 1986)

STATION	CONCENTRATION (ug/g)				STATION	CONCENTRATION (ug/g)			
	MEAN	MEAN	REPLICATES			MEAN	MEAN	REPLICATES	
	SVR	SFR	SVR	SFR		SVR	SFR	SVR	SFR
4A	55533	935667	74800	960000	25C	48700	951333	44200	956000
			40300	948000				50900	949000
			51500	899000				51000	949000
4B	41333	958667	36800	963000	26	43333	956667	40600	959000
			39400	961000				46100	954000
			47800	952000				43300	957000
5	89533	910333	60800	939000	27	58500	942000	58500	942000
			133000	867000					
			74800	925000					
6	69367	930667	72900	927000	28	53033	947000	48500	952000
			70100	930000				57700	942000
			65100	935000				52900	947000
7A	67633	932333	68900	931000	29	40133	959667	38000	962000
			68200	932000				44700	955000
			65800	934000				37700	962000
7B	57300	943000	59100	941000	30	40067	960000	40300	960000
			50500	950000				42600	957000
			62300	938000				37300	963000
8	50633	949333	50100	950000	31	26950	973000	25000	975000
			51600	948000				28900	971000
			50200	950000					
9	54600	944333	61400	940000	32	85767	754667	88500	898000
			46100	939000				88700	891000
			56300	954000				80100	475000
10A	58667	941333	56300	944000	33A	88000	982000	88000	982000
			59200	941000					
			60500	939000					
10B	67367	932667	66700	933000	33B	87500	992667	87900	970000
			54300	946000				87600	938000
			81100	919000				87000	1070000
11A	55300	944667	63600	936000	34	87500	1026667	87400	1000000
			45200	955000				87100	1060000
			57100	943000				88000	1020000

APPENDIX II SEDIMENT VOLATILE AND FIXED RESIDUE CONCENTRATIONS IN VANCOUVER HARBOUR (1985 - 1986)

STATION	CONCENTRATION (ug/g)				STATION	CONCENTRATION (ug/g)			
	MEAN	MEAN	REPLICATES			MEAN	MEAN	REPLICATES	
	SVR	SFR	SVR	SFR		SVR	SFR	SVR	SFR
11B MAY85	29367	968333	41000	998000	35 MAY85	87133	1036000	86300	1080000
			25400	972000				86500	1070000
			21700	935000				88600	958000
OCT85	51967	915000	41400	959000	OCT85	101833	898333	97500	903000
			51000	850000				100000	900000
			63500	936000				208000	892000
JAN86	64433	935667	67200	933000	JAN86	89200	911000	93200	907000
			60400	940000				126000	874000
			65700	934000				48400	952000
MAY86	36933	951000	37800	926000	MAY86	105667	894333	10800	892000
			37500	963000				103000	897000
			35500	964000				106000	894000
SEPT86	23033	977000	22600	977000	SEPT86	99933	900000	101000	899000
			32200	968000				101000	899000
			14300	986000				97800	902000
12	25433	974667	22900	977000	37A	103467	896667	95400	905000
			26200	974000				106000	894000
			27200	973000				109000	891000
13A	17533	982333	18500	981000	37B	103733	896333	106000	894000
			19900	980000				99200	894000
			14200	986000				106000	901000
13B	25433	969000	14200	969000	37C	102233	897667	103000	897000
			31000	969000				98700	901000
			31100	969000				105000	895000
15 JAN86	48767	951333	43700	956000	38 JAN86	104000	896000	104000	896000
			49400	951000					
			53200	947000					
MAY86	38133	961667	41000	959000	MAY86	113667	886333	114000	886000
			37800	962000				112000	888000
			35600	964000				115000	885000
SEP86	58100	942000	48900	951000	SEP86	100433	899667	104000	896000
			58200	942000				100000	900000
			67200	933000				97300	903000

APPENDIX II SEDIMENT VOLATILE AND FIXED RESIDUE CONCENTRATIONS IN VANCOUVER HARBOUR (1985 - 1986)

STATION	CONCENTRATION (ug/g)				STATION	CONCENTRATION (ug/g)			
	MEAN	MEAN	REPLICATES			MEAN	MEAN	REPLICATES	
	SVR	SFR	SVR	SFR		SVR	SFR	SVR	SFR
16 MAY85	55567	932333	58700	928000	39A	100333	899333	122000	878000
			56100	935000				90500	909000
			51900	934000				88500	911000
OCT85	51367	949333	42500	957000	39B	101900	898000	91800	908000
			42100	958000				112000	888000
			66500	933000					
MAY86	40700	959333	37300	963000	39C	98900	901000	99000	901000
			44900	955000				95700	904000
			39900	960000				102000	898000
SEPT86	25867	972667	28400	972000	39D	102067	898000	96200	904000
			23900	971000				101000	899000
			25300	975000				109000	891000
17	51600	948333	47300	953000	39E	108667	891333	109000	891000
			50600	949000				109000	891000
			56900	943000				108000	892000
18	36000	964000	40800	959000	40	82800	917000	86000	914000
			29700	963000				93800	906000
			37500	970000				68600	931000
19 MAY85	47300	938667	53900	932000	41	118000	882000	118000	882000
			42000	946000				117000	883000
			46000	938000				119000	881000
OCT85	51767	948333	45500	955000					
			67900	932000					
			41900	958000					
JAN86	52833	914000	45300	955000					
			49000	851000					
			64200	936000					
MAY86	46200	954000	44700	955000					
			48500	952000					
			45400	955000					
SEPT86	53700	946333	51500	944000					
			56100	948000					
			53500	947000					

APPENDIX E

VANCOUVER HARBOUR BENTHIC ENVIRONMENTAL QUALITY STUDIES

MAY 1985 - SEPTEMBER 1986

TRACE METALS IN TISSUE

By

M. THOMAS
D. GOYETTE

OCTOBER 1989

REVIEW NOTICE

Data reports are prepared to make data available without full analysis or interpretation. This report has been reviewed by Marine Programs, Environmental Protection, and approved for limited distribution. For further information please contact:

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TABLE OF CONTENTS

Page

REVIEW NOTICE i

TABLE OF CONTENTS ii

List of Figures iii

1.0 INTRODUCTION 1

2.0 MATERIAL AND METHODS 2

2.1 Study Area 2

2.2 Field Collection 4

2.3 Laboratory Analysis 4

3.0 RESULTS 6

REFERENCES 37

ACKNOWLEDGEMENTS 38

APPENDIX I COORDINATES AND DEPTHS FOR OTTER TRAWL SURVEYS IN VANCOUVER HARBOUR (1985-1986) 39

APPENDIX II TISSUE TRACE METAL CONCENTRATIONS - RAW DATA - VANCOUVER HARBOUR 41

A. MAY 1985 42

B. OCTOBER 1985 71

C. JANUARY 1986 87

APPENDIX III TISSUE TRACE METAL CONCENTRATIONS - DESCRIPTIVE STATISTICS - VANCOUVER HARBOUR 97

A. MAY 1985 98

B. OCTOBER 1985 133

C. JANUARY 1986 149

APPENDIX IV TRACE METAL CONCENTRATIONS OF STANDARD REFERENCE MATERIALS (BOVINE LIVER AND TORT-1, LOBSTER HEPATOPANCREAS) AND PERCENT RECOVERY BY EP LABORATORY FOR EACH SET OF SAMPLES 158

A. MAY 1985 159

B. OCTOBER 1985 164

C. JANUARY 1986 173

LIST OF FIGURES

Figure		Page
1	OTTER TRAWL LOCATIONS - VANCOUVER HARBOUR (1985-1986) ...	3
2	TRACE METAL CONCENTRATIONS IN PANDALID SHRIMP TAIL MUSCLE AND HEPATOPANCREAS TISSUE - VANCOUVER HARBOUR (1985-1986)	7
	(a) ALUMINUM (b) ARSENIC (c) CADMIUM (d) CHROMIUM (e) COPPER (f) IRON (g) MERCURY (h) LEAD (i) ZINC	
3	TRACE METAL CONCENTRATIONS IN DUNGENESS CRAB (Cancer magister) MUSCLE, HEPATOPANCREAS AND GILL TISSUE - VANCOUVER HARBOUR (1985-1986)	17
	(a) ALUMINUM (b) ARSENIC (c) CADMIUM (d) CHROMIUM (e) COPPER (f) IRON (g) MERCURY (h) LEAD (i) ZINC	
4	TRACE METAL CONCENTRATIONS IN ENGLISH SOLE (Parophyrys vetulus) MUSCLE, LIVER AND GILL TISSUE - VANCOUVER HARBOUR (1985-1986)	27
	(a) ALUMINUM (b) ARSENIC (c) CADMIUM (d) CHROMIUM (e) COPPER (f) IRON (g) MERCURY (h) LEAD (i) ZINC	

1.0 INTRODUCTION

In May of 1985, Environment Canada initiated a series of benthic environmental quality studies in Vancouver Harbour following a literature review and preliminary impact assessment by Waters (1985a, 1985b). Emphasis was placed on sampling benthic epifauna, demersal fish, and surficial bottom sediment for selected trace metals and organic chemicals. Species abundance and distribution based on otter trawl catch data (Goyette and Thomas, 1987) and prevalence of liver tissue abormalities in flatfish (Goyette et al., 1988) were also examined.

As an active industrial and urban port, Vancouver Harbour is subject to metal contamination from bulk loading terminals (metal concentrates), metal finishing plant effluents, shipyards (blasting abrasives, anti-fouling paints etc.), municipal waste discharges, oil refinery effluents, general urban runoff, among other sources. Accumulation of trace metals in the sediment can be toxic to benthic biota depending on bioavailability (chemical state). Trace metal levels in sediment and benthic organisms can be indicative of environmental quality.

Thomas and Goyette (1989a) have documented trace metal levels in Vancouver Harbour sediment between May 1985 and January 1986. The current report presents trace metal levels in selected organisms throughout Vancouver Harbour during the same time period. The organisms collected included commercially important species, pandalid shrimp (Pandalus danae, P. borealis, P. hypsinotus, and Pandalopsis dispar) and Dungeness crab (Cancer magister). Several species of bottomfish including the dominant English sole (Parophyrys vetulus) were also collected.

2.0 METHOD AND MATERIALS

2.1 Study Area

Vancouver Harbour (Point Atkinson to Port Moody Arm) was subdivided into four hydrographic regions for study - outer harbour, inner harbour, central harbour and eastern harbour. The eleven otter trawl sites selected have been shown in Figure 1. Surveys were conducted from the research vessel CSS Vector in May 1985, October 1985 and January 1986 according to the sampling schedule below.

AREA	STATION	TOTAL NUMBER SURVEYS	MAY 1985	OCT 1985	JAN 1986
OUTER HARBOUR	Pacific Environment Institute (PEI)	3	X	X	X
INNER HARBOUR					
North Shore	Burrard Yarrows (BY)	3	X	X	X
Centre	Centre (CT)	1			X
South Shore	Coal Harbour (CH)	3	X	X	X
	Vanterm (VT)	1	X		
	Sterling (ST)	2	X	X	
CENTRAL HARBOUR	Chevron (CV)	1	X		
	Cates Park (CP)	1	X		
	Boulder Rock (BR)	1	X		
EASTERN HARBOUR					
Port Moody Arm	Port Moody (PM)	3	X	X	X
	IOCO	1			X

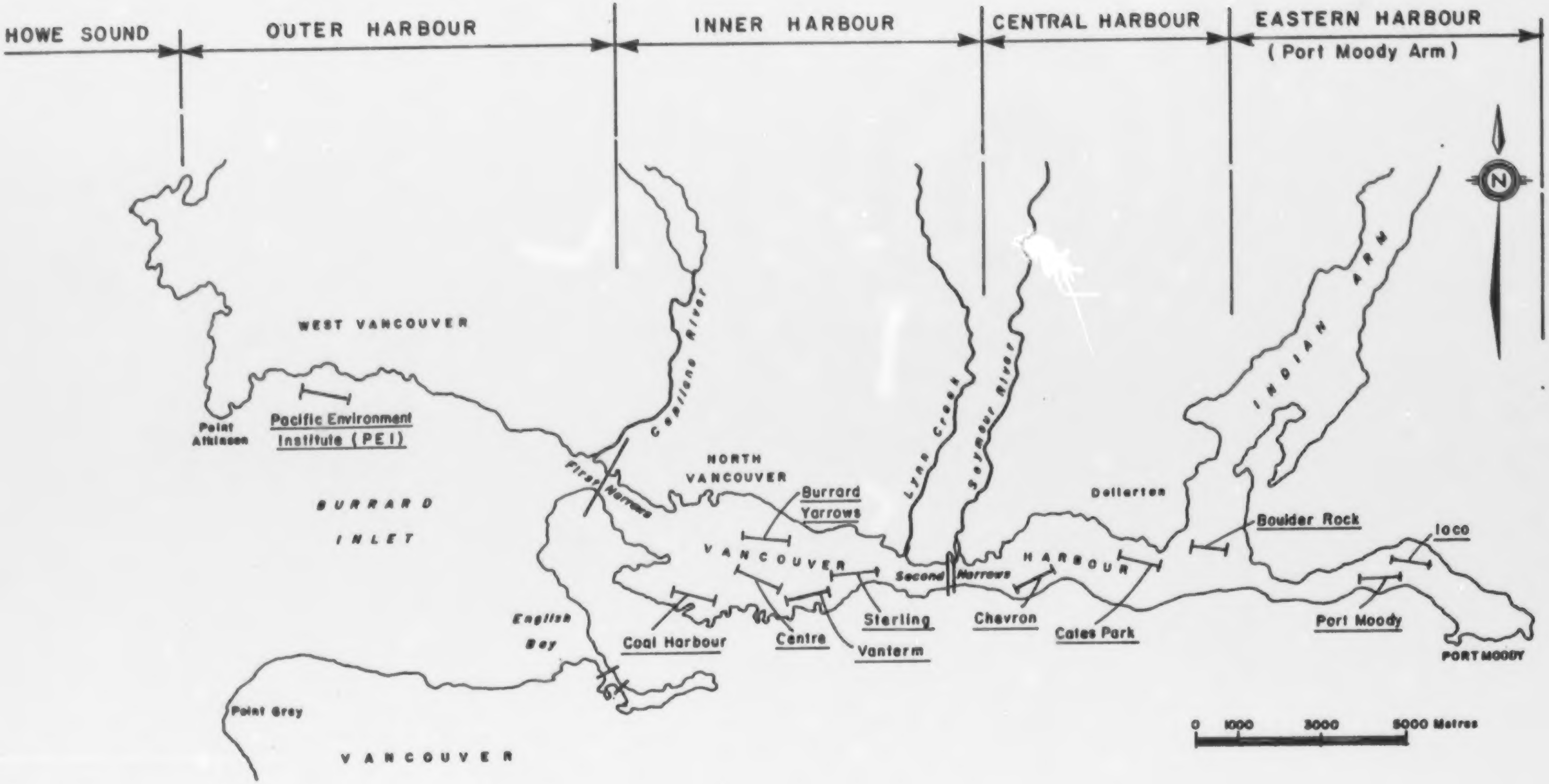

HOWE SOUND
OUTER HARBOUR
INNER HARBOUR
CENTRAL HARBOUR
EASTERN HARBOUR
(Port Moody Arm)
N
WEST VANCOUVER
Point Atkinson
Pacific Environment Institute (PEI)
BURRARD INLET
First Narrows
Capilano River
NORTH VANCOUVER
Burrard Yarrows
VANCOUVER
Coal Harbour
Centre
Sterling
Vanterm
Lynn Creek
Seymour River
Second Narrows
HARBOUR
Chevron
Cates Park
Dollarton
INDIAN ARM
Boulder Rock
Ioco
Port Moody
PORT MOODY
English Bay
Point Grey
VANCOUVER
0
1000
3000
5000 Metres

FIGURE I OTTER TRAWL LOCATIONS - VANCOUVER HARBOUR (1985-1986)

2.2 Field Collection

Biota samples were collected using a small otter trawl with a 3.8 cm mesh net and a 5.8 metre throat. The trawl was towed for a distance of approximately 0.9 km at a speed of 1.5 knots. Trawl catches were sorted and enumerated by species; lengths and weights recorded (refer to Goyette and Thomas, 1987).

Tissue samples were taken from the selected organisms considered to be of importance to commercial or sport fisheries in Vancouver Harbour. Dissections were done immediately after each trawl using sterilized stainless steel scalpels and forceps as follows:

shrimp : tail muscle (composites of 2) and hepatopancreas (composites of 6);
crab : leg and claw muscle and hepatopancreas (composites of 2);
fish : dorsal muscle with skin removed, liver and gills (without gill arch).

Fish were kept alive in plastic tubs with running seawater until processed. Efforts were made to maintain a contamination-free environment throughout the dissections. All tissue samples were frozen individually in "whirlpak" bags immediately following dissection.

2.3 Laboratory Analysis

Tissue trace metals were analyzed at the Environmental Protection Laboratory in West Vancouver according to a modified version of Swingle and Davidson (1979). Standard reference materials including bovine liver (NBS) and TORT-1 lobster hepatopancreas (NRCC) were analyzed with each set of samples.

Tissue samples were freeze-dried and homogenized; 0.3 gm samples were oxidized in a low-temperature oxygen asher. The ashed samples which contain the metallic salts were then brought into solution by digesting with 3:1 HNO_3-HCl. Deionized water was added to make 25 ml solutions before the samples were analyzed using a "Jarrel-Ash 975" inductively coupled argon plasma optical emission spectrophotometer (ICP-AES).

Low level cadmium and lead concentrations were analyzed using a "Varian 1475" atomic absorption spectrophotometer with a "Varian GTA-95" graphite furnace attachment (GF-AAS). For mercury, 0.1 gm of the freeze-dried and homogenized sample was dissolved in 4:1 sulphuric acid-water mixture. These solutions were further oxidized with 50% peroxide, heated, cooled and diluted with 1.0 ml HNO_3 and volumized to 50 ml with diagnosed water. Mercury levels were measured by cold vapour atomic absorption (CVAA) using a "Pharmacia" LCD mercury monitor with a 30cm absorption cell.

3.0 RESULTS

The levels of selected metals (Al, As, Cd, Cr, Cu, Fe, Hg, Pb and Zn) in the tissue of pandalid shrimp, Dungeness crab and English sole are illustrated in Figures 2, 3, and 4 respectively. The complete scan of trace metal concentrations for all the organisms analyzed can be found in Appendix II; descriptive statistics tables are provided in Appendix III. Note that detection limits varied depending on the quality of sample. For statistical calculations, the detection limit was assigned as the value for cases where the actual concentration was below the sensitivity level. Analyses of standard reference materials are detailed in Appendix IV.

FIGURE 2

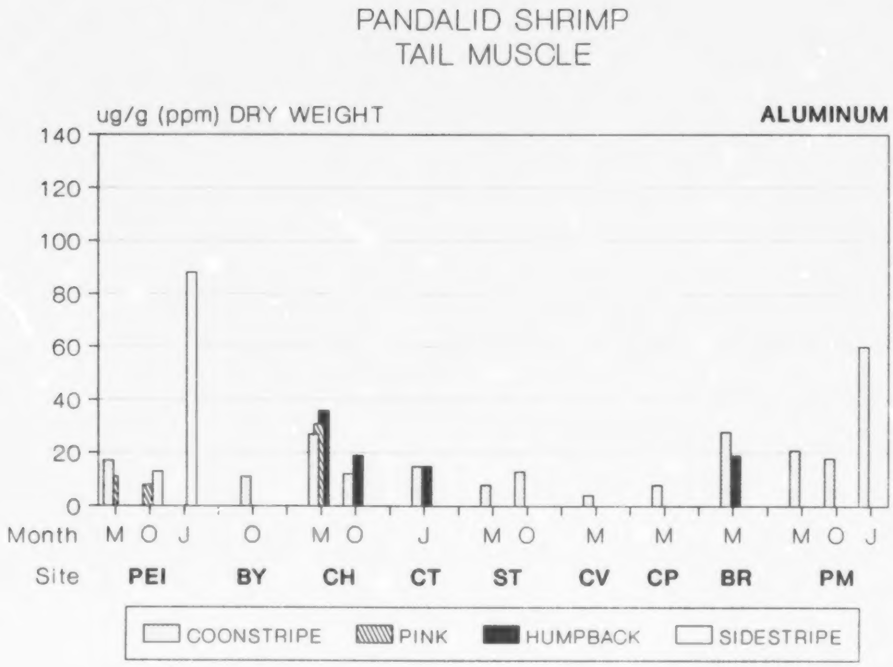
TRACE METAL CONCENTRATIONS IN PANDALID SHRIMP TAIL, MUSCLE AND HEPATOPANCREAS TISSUE - VANCOUVER HARBOUR (1985-1986)

LEGEND

(a) Aluminum
(b) Arsenic
(c) Cadmium
(d) Chromium
(e) Copper
(f) Iron
(g) Mercury
(h) Lead
(i) Zinc

PEI = Pacific Environment Institute
BY = Burrard Yarrows
CH = Coal Harbour
CT = Centre
ST = Sterling
CV = Chevron
CP = Cates Park
BR = Boulder Rock
PM = Port Moody

M = May 1985
O = October 1985
J = January 1986


PANDALID SHRIMP
TAIL MUSCLE

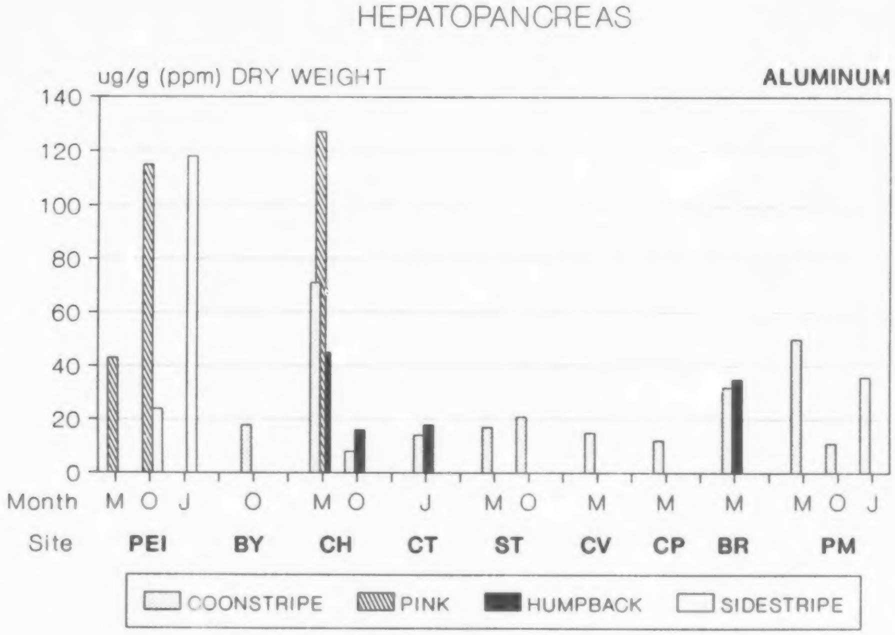
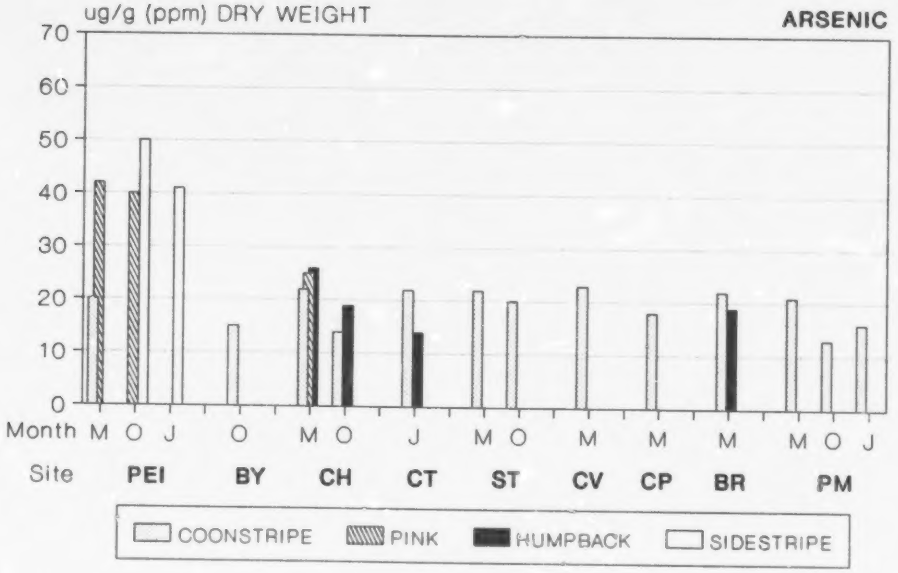

HEPATOPANCREAS

FIGURE 2A TRACE METAL CONCENTRATIONS IN PANDALID SHRIMP TAIL MUSCLE, AND HEPATOPANCREAS TISSUE - VANCOUVER HARBOUR (1985-1986) - ALUMINUM


PANDALID SHRIMP
TAIL MUSCLE

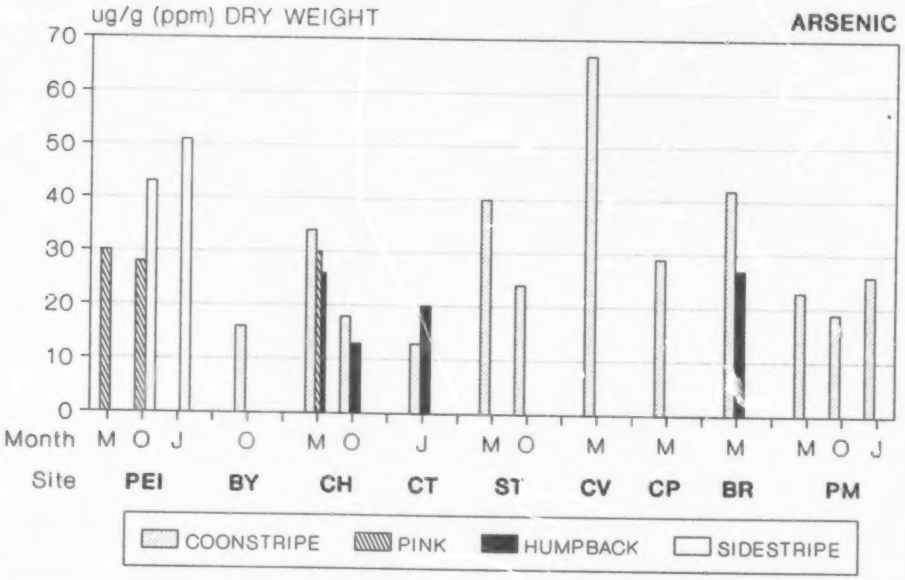
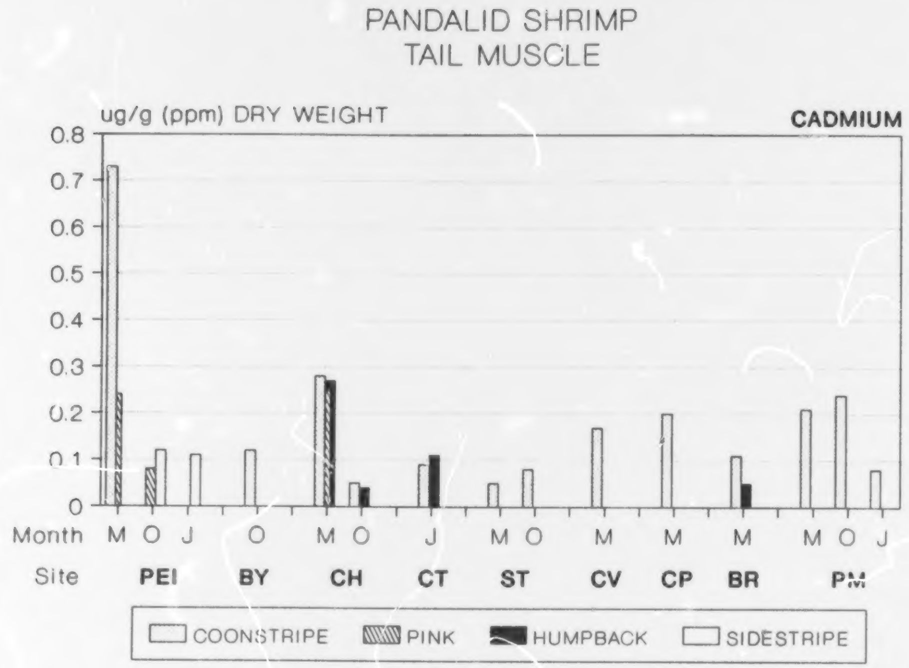

HEPATOPANCREAS

FIGURE 2B TRACE METAL CONCENTRATIONS IN PANDALID SHRIMP TAIL MUSCLE, AND HEPATOPANCREAS TISSUE - VANCOUVER HARBOUR (1985-1986) - ARSENIC



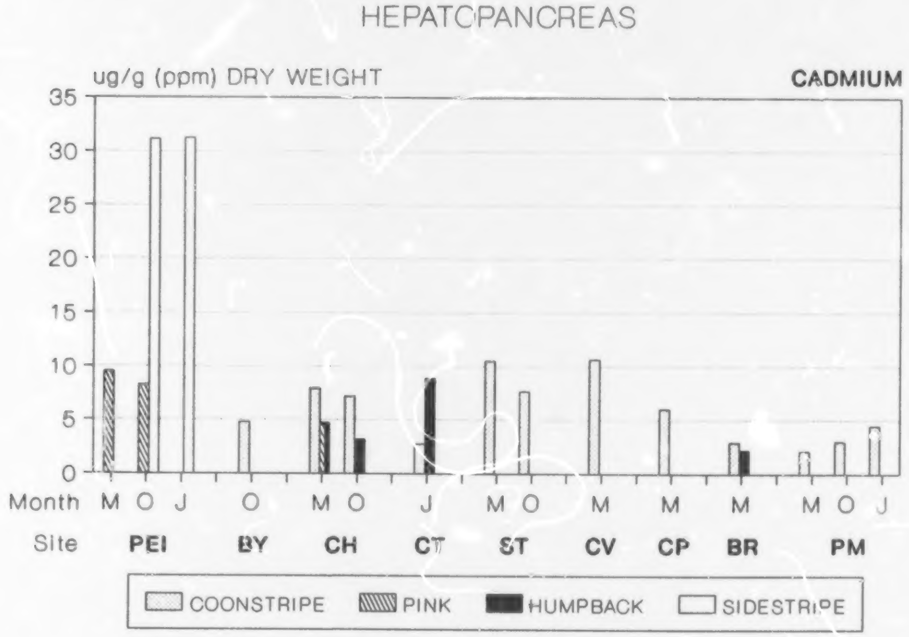
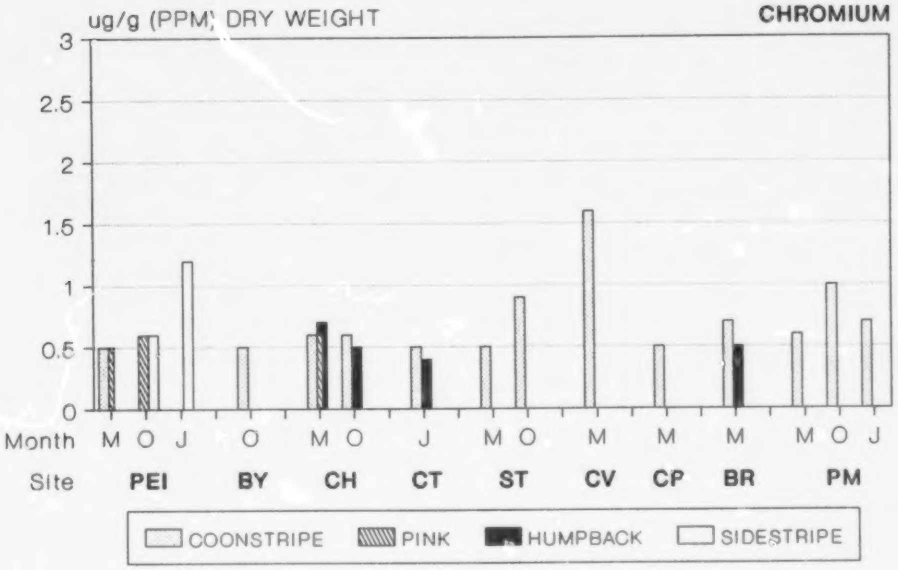


FIGURE 2C TRACE METAL CONCENTRATIONS IN PANDALID SHRIMP TAIL MUSCLE, AND HEPATOPANCREAS TISSUE - VANCOUVER HARBOUR (1985-1986) - CADMIUM

PANDALID SHRIMP
TAIL MUSCLE



HEPATOPANCREAS

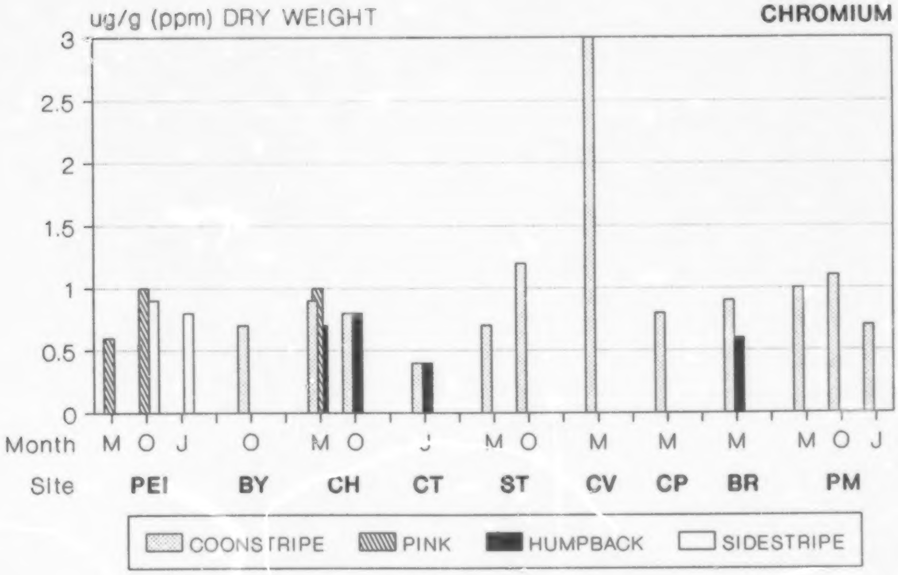
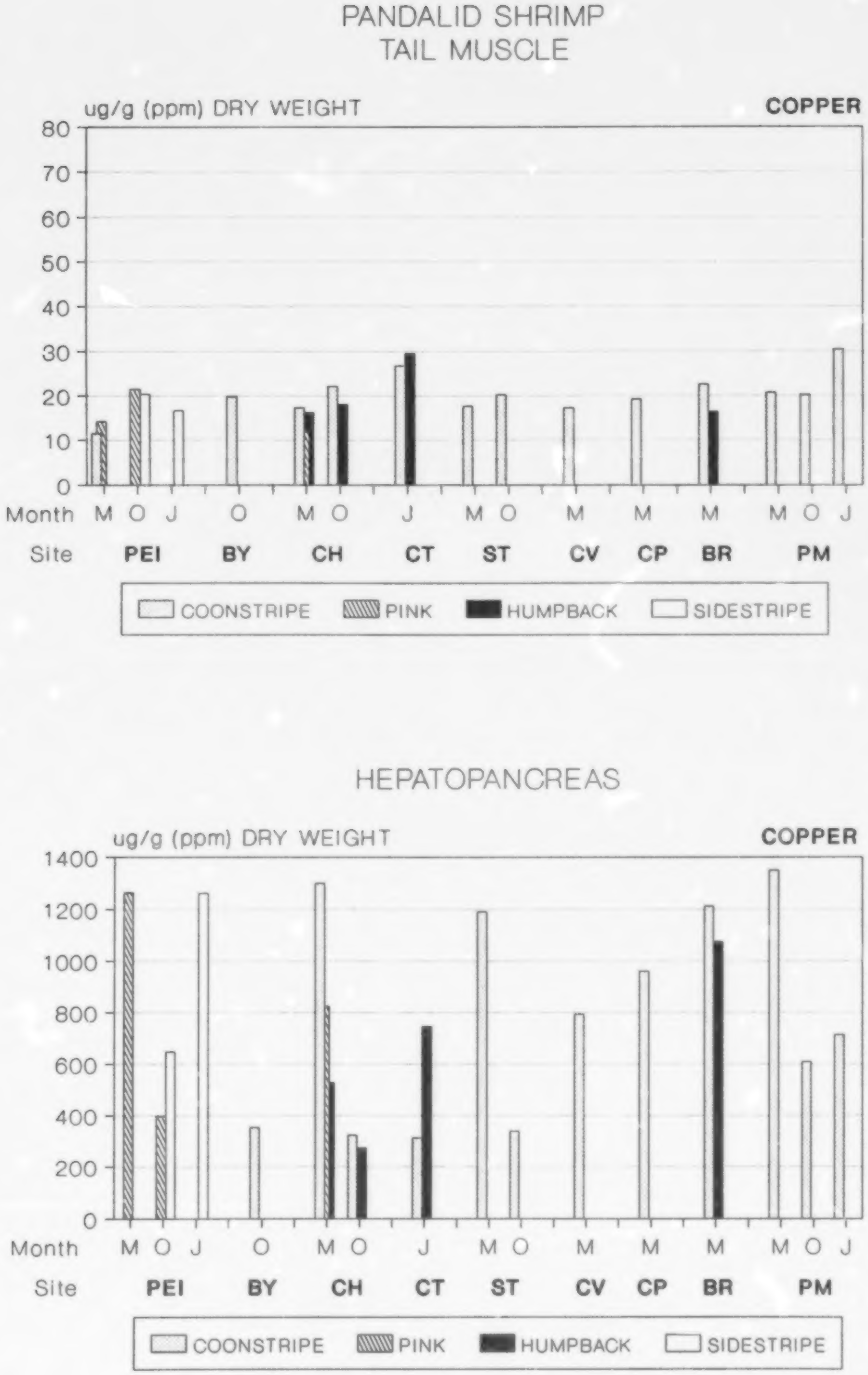


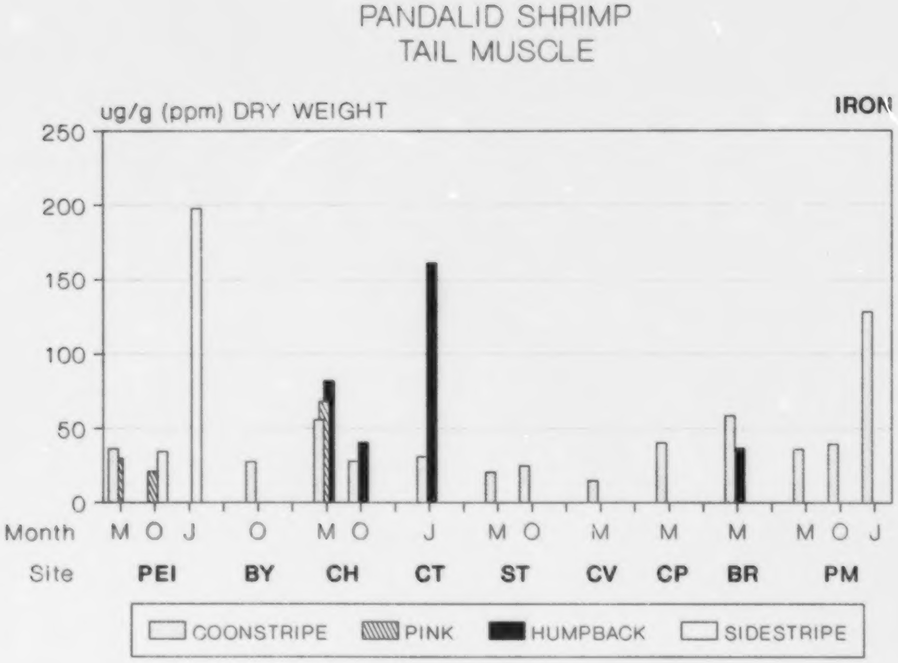
TABLE 2D TRACE METAL CONCENTRATIONS IN PANDALID SHRIMP TAIL MUSCLE, AND HEPATOPANCREAS TISSUE - VANCOUVER HARBOUR (1985-1986) - CHROMIUM



PANDALID SHRIMP
TAIL MUSCLE

HEPATOPANCREAS

FIGURE 2E TRACE METAL CONCENTRATIONS IN PANDALID SHRIMP TAIL MUSCLE, AND HEPATOPANCREAS TISSUE - VANCOUVER HARBOUR (1985-1986) - COPPER



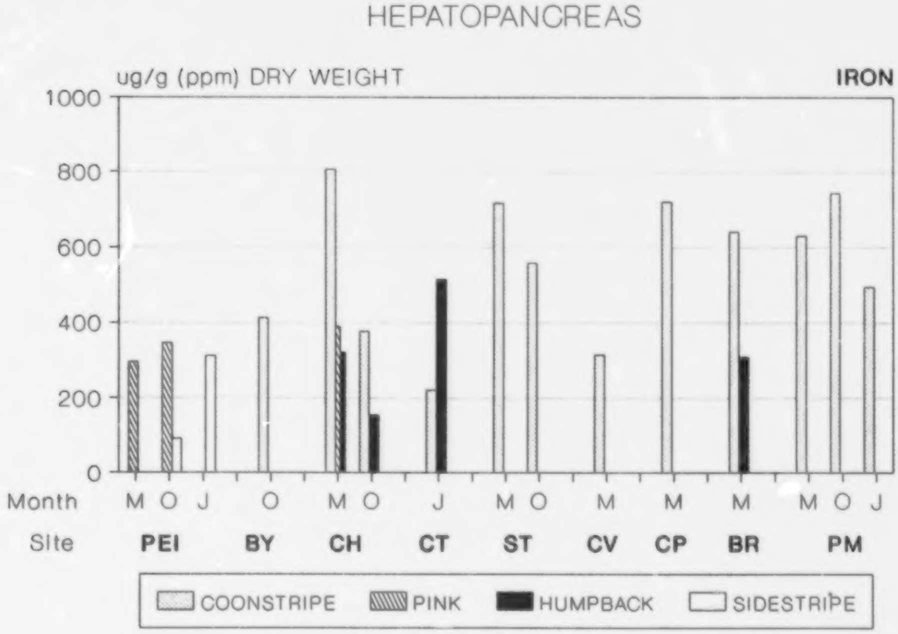
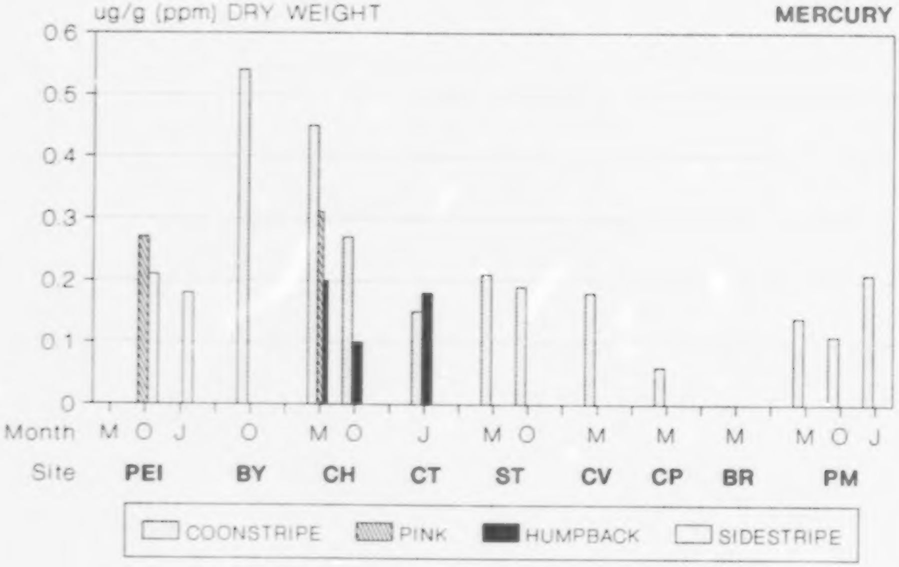


FIGURE 2F TRACE METAL CONCENTRATIONS IN PANDALID SHRIMP TAIL MUSCLE, AND HEPATOPANCREAS TISSUE - VANCOUVER HARBOUR (1985-1986) - IRON

PANDALID SHRIMP
TAIL MUSCLE



HEPATOPANCREAS

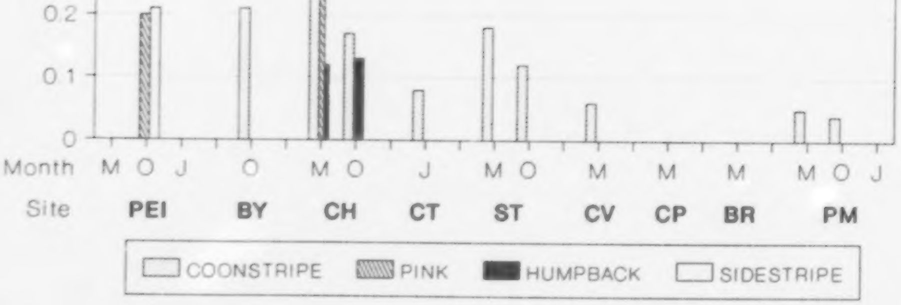
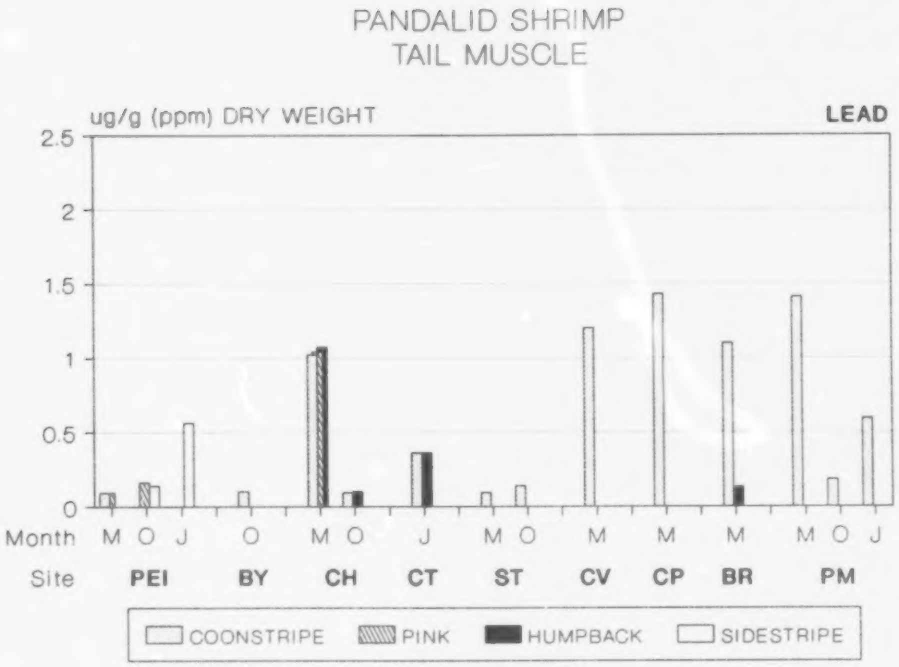
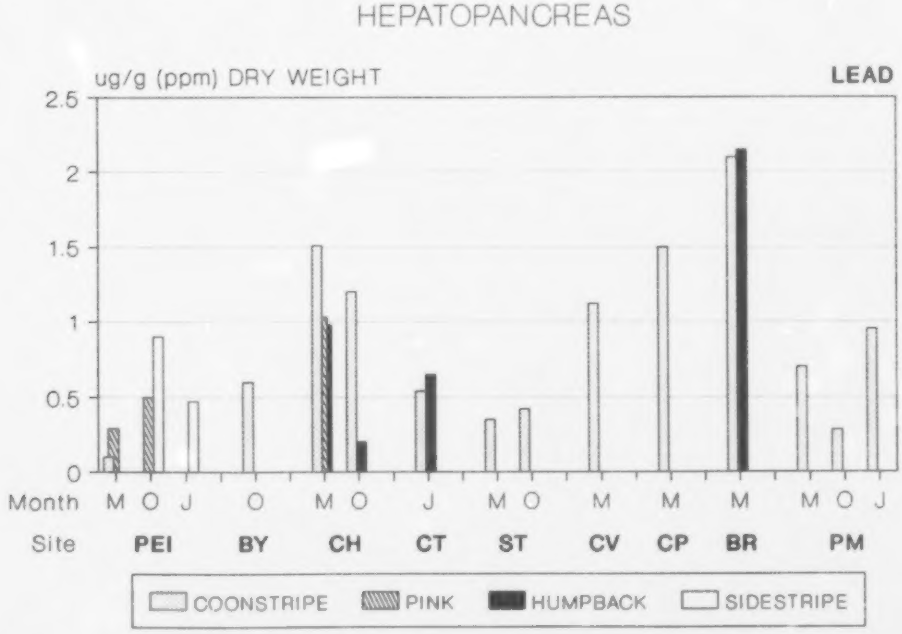


FIGURE 2G TRACE METAL CONCENTRATIONS IN PANDALID SHRIMP TAIL MUSCLE, AND HEPATOPANCREAS TISSUE - VANCOUVER HARBOUR (1985-1986) - MERCURY

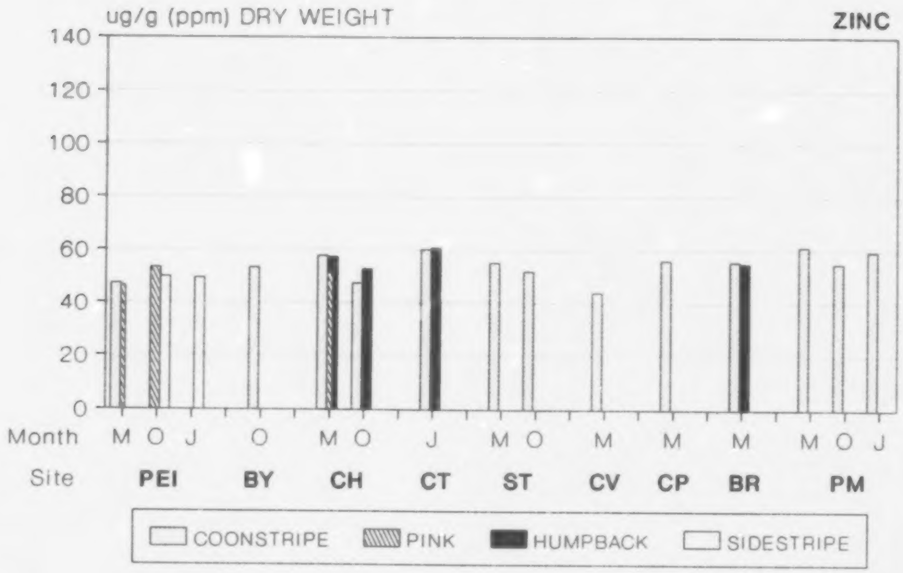


PANDALID SHRIMP
TAIL MUSCLE



HEPATOPANCREAS

FIGURE 2H TRACE METAL CONCENTRATIONS IN PANDALID SHRIMP TAIL MUSCLE, AND HEPATOPANCREAS TISSUE - VANCOUVER HARBOUR (1985-1986) - LEAD


PANDALID SHRIMP
TAIL MUSCLE

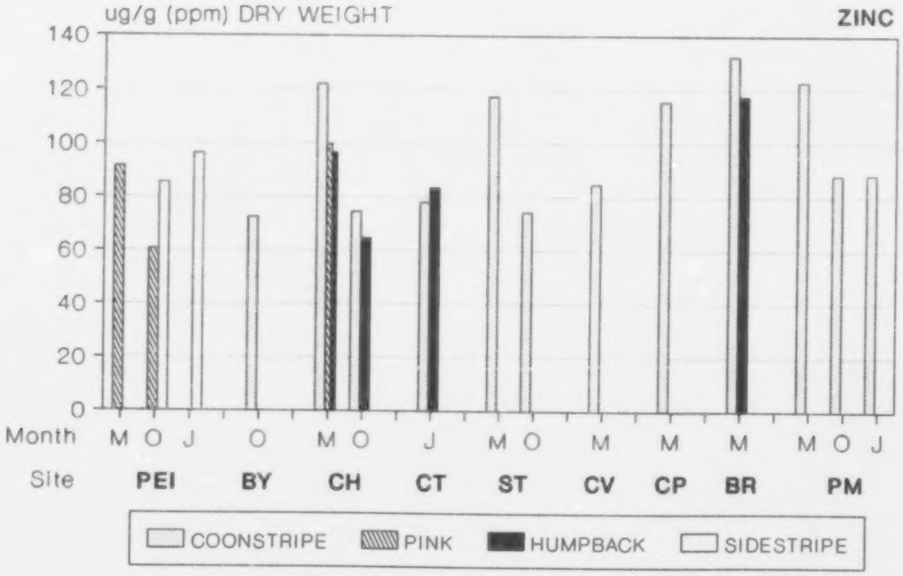

HEPATOPANCREAS

FIGURE 2I TRACE METAL CONCENTRATIONS IN PANDALID SHRIMP TAIL MUSCLE, AND HEPATOPANCREAS TISSUE - VANCOUVER HARBOUR (1985-1986) - ZINC

FIGURE 3

TRACE METAL CONCENTRATIONS IN DUNGENESS CRAB (*Cancer magister*) MUSCLE, HEPATOPANCREAS AND GILL TISSUE - VANCOUVER HARBOUR (1985-1986)

LEGEND

(a) Aluminium
(b) Arsenic
(c) Cadmium
(d) Chromium
(e) Copper
(f) Iron
(g) Mercury
(h) Lead
(i) Zinc

PEI = Pacific Environment Institute
BY = Burrard Yarrows
CH = Coal Harbour
CT = Centre
VT = Vanterm
ST = Sterling
CV = Chevron
CP = Cates Park
BR = Boulder Rock
PM = Port Moody
ICO = Ioco

M = May 1985
O = October 1985
J = January 1986

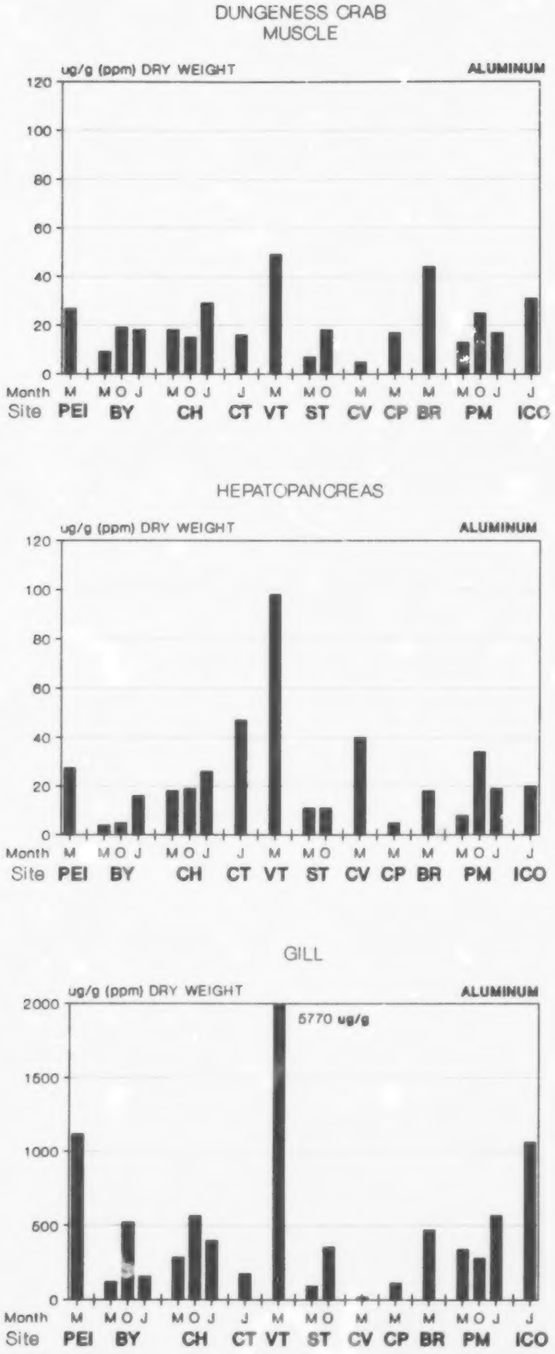
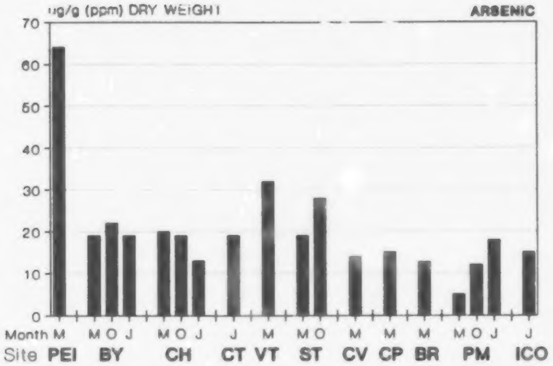
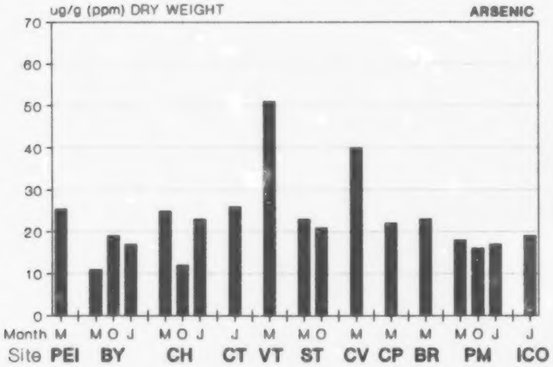


FIGURE 3A TRACE METAL CONCENTRATIONS IN DUNGENESS CRAB (*Cancer magister*) MUSCLE, HEPATOPANCREAS, AND GILL TISSUE - VANCOUVER HARBOUR (1985-1986) - ALUMINUM

DUNGENESS CRAB
MUSCLE



HEPATOPANCREAS



GILL

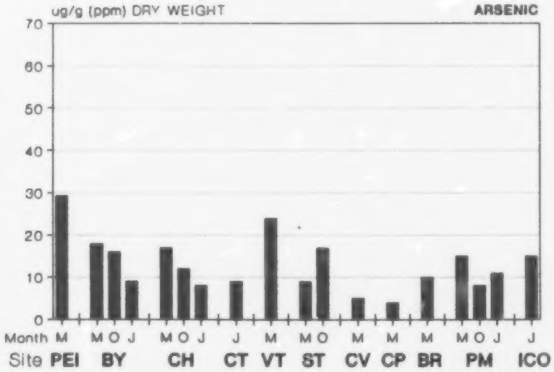
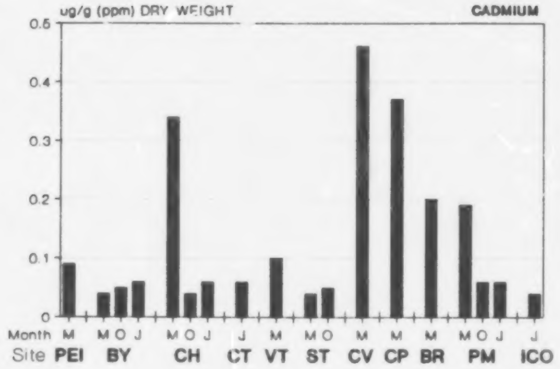
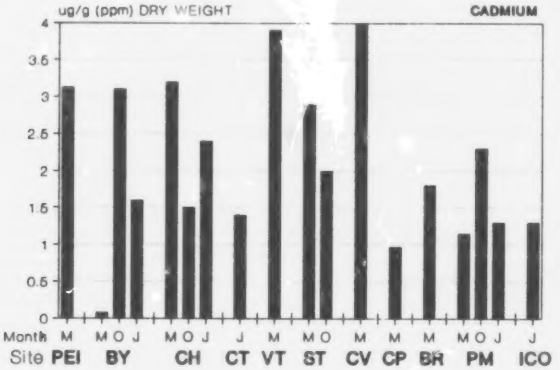


FIGURE 3B TRACE METAL CONCENTRATIONS IN DUNGENESS CRAB (Cancer magister) MUSCLE, HEPATOPANCREAS, AND GILL TISSUE - VANCOUVER HARBOUR (1985-1986) - ARSENIC

DUNGENESS CRAB
MUSCLE



HEPATOPANCREAS



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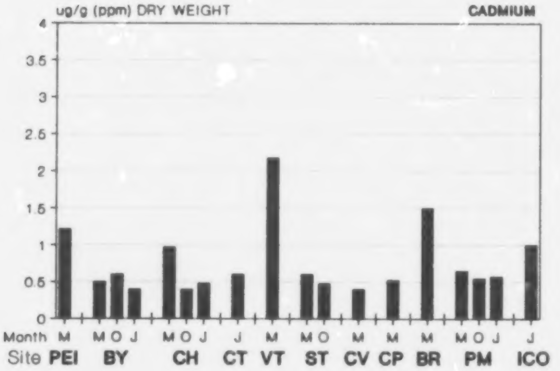
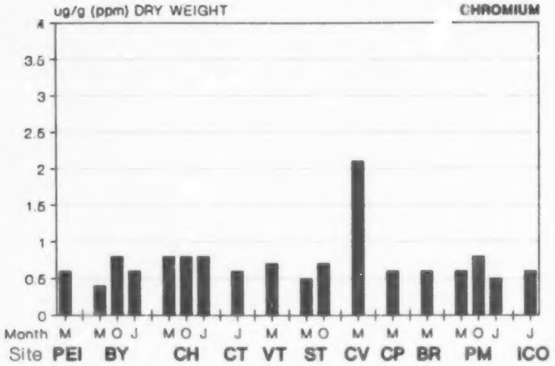
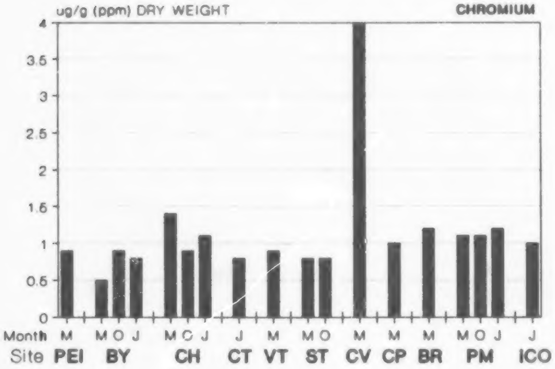


FIGURE 3C TRACE METAL CONCENTRATIONS IN DUNGENESS CRAB (*Cancer magister*) MUSCLE, HEPATOPANCREAS, AND GILL TISSUE - VANCOUVER HARBOUR (1985-1986) - CADMIUM

DUNGENESS CRAB
MUSCLE



HEPATOPANCREAS



GILL

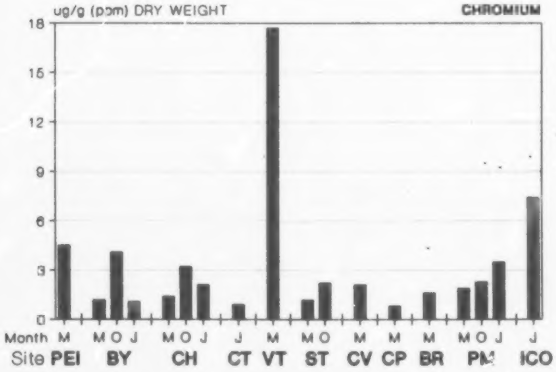


FIGURE 3D TRACE METAL CONCENTRATIONS IN DUNGENESS CRAB (Cancer magister) MUSCLE, HEPATOPANCREAS, AND GILL TISSUE - VANCOUVER HARBOUR (1985-1986) - CHROMIUM

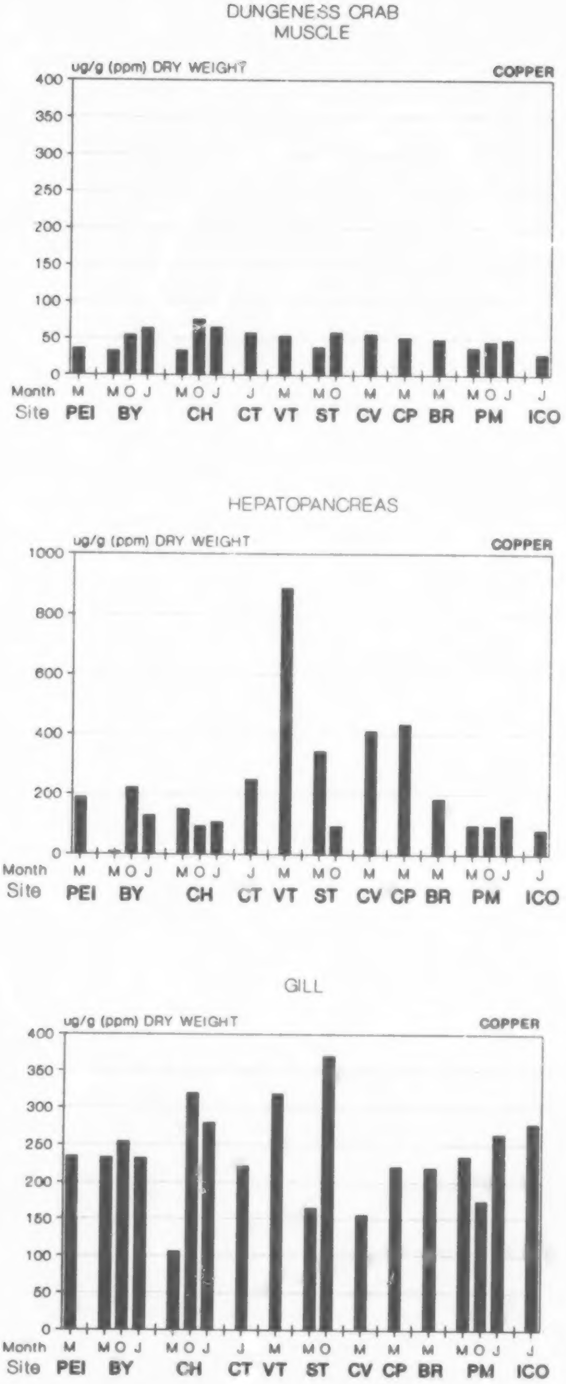


FIGURE 3E TRACE METAL CONCENTRATIONS IN DUNGNESS CRAB (Cancer magister) MUSCLE, HEPATOPANCREAS, AND GILL TISSUE - VANCOUVER HARBOUR (1985-1986) - COPPER

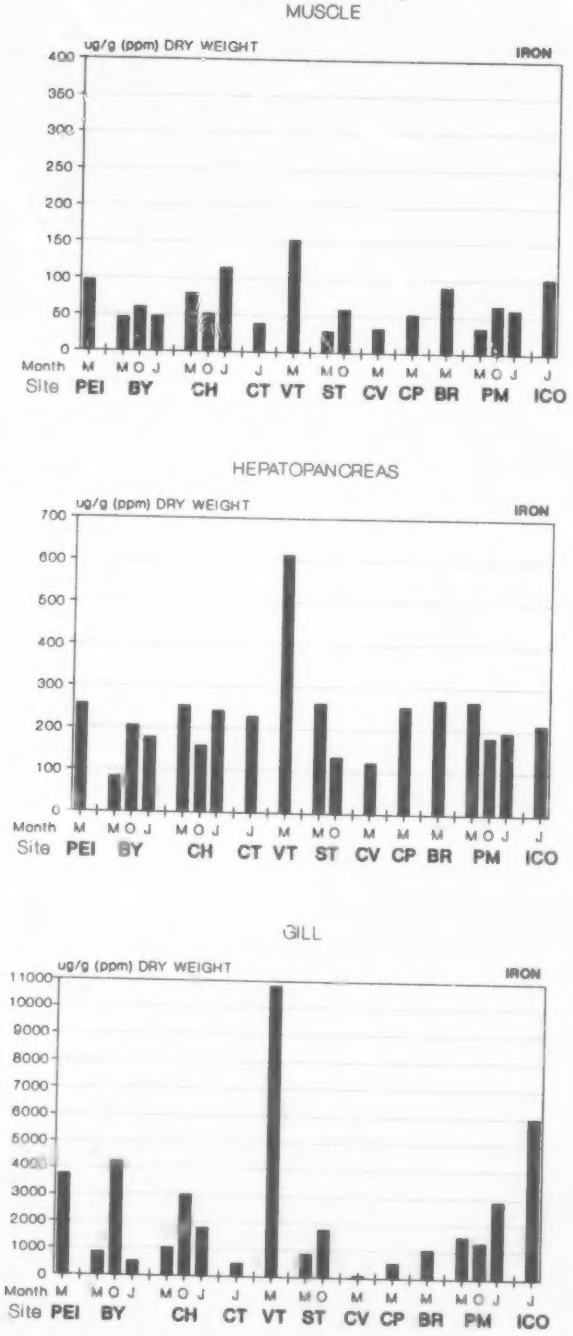
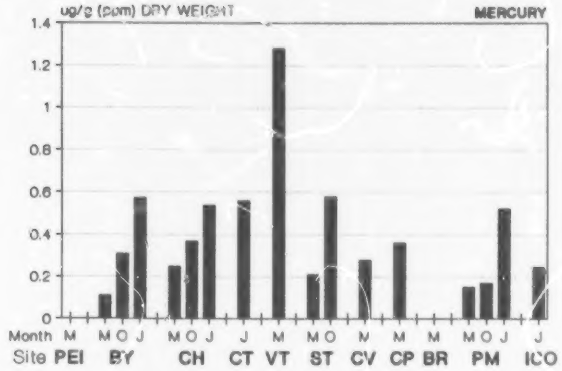
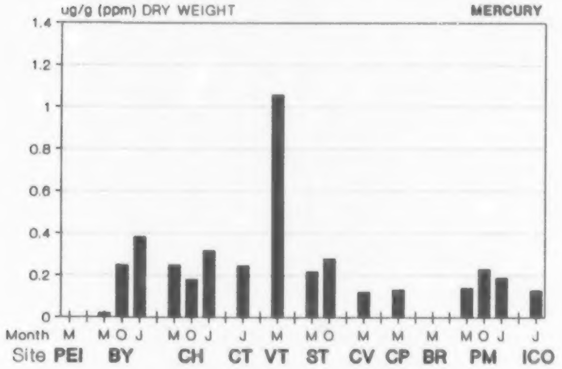


FIGURE 3F TRACE METAL CONCENTRATIONS IN DUNGENESS CRAB (*Cancer magister*) MUSCLE, HEPATOPANCREAS, AND GILL TISSUE - VANCOUVER HARBOUR (1985-1986) - IRON

DUNGENESS CRAB
MUSCLE



HEPATOPANCREAS



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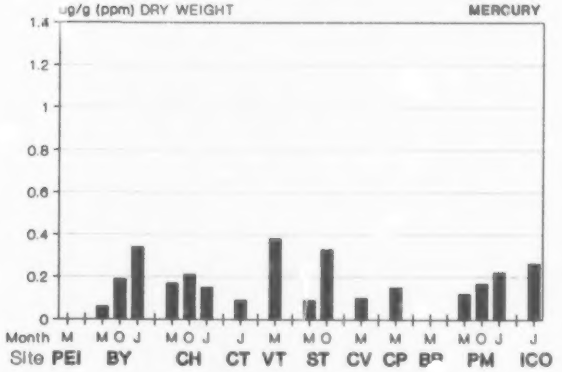


FIGURE 3G TRACE METAL CONCENTRATIONS IN DUNGENESS CRAB (*Cancer magister*) MUSCLE, HEPATOPANCREAS, AND GILL TISSUE - VANCOUVER HARBOUR (1985-1986) - MERCURY

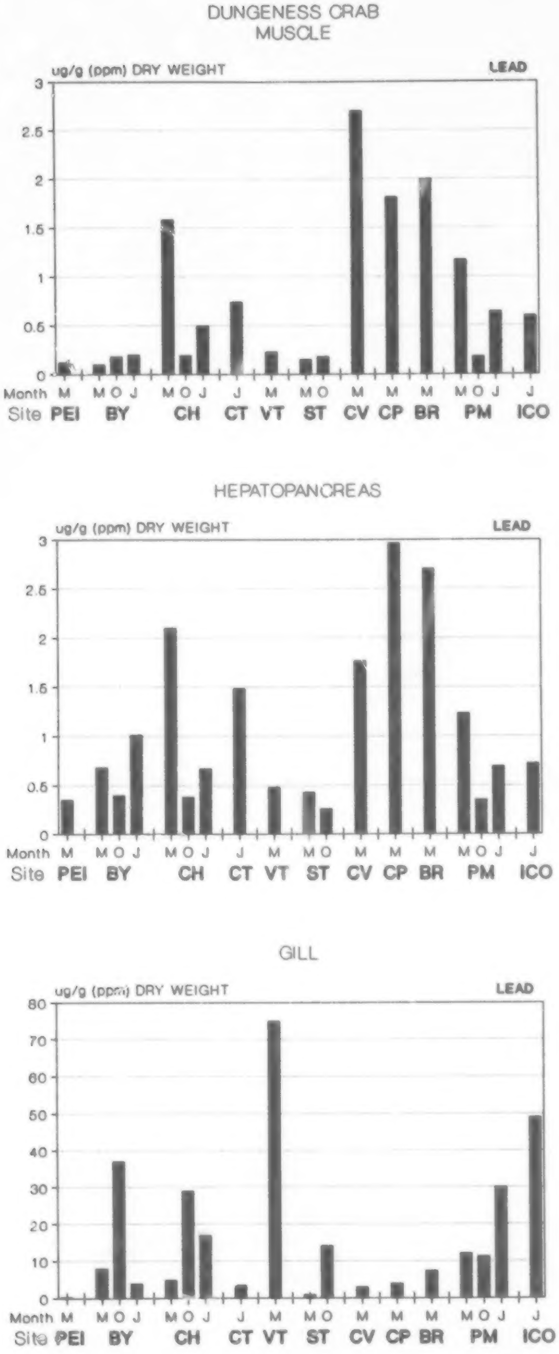
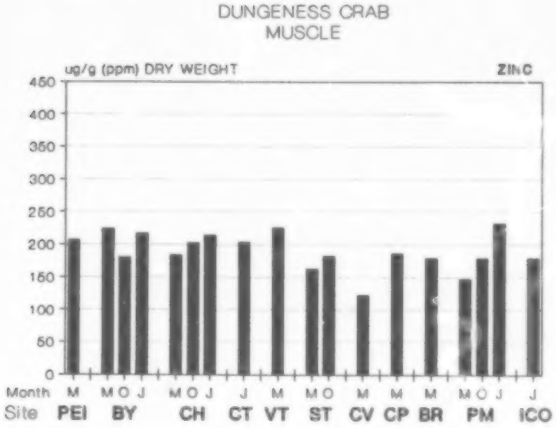
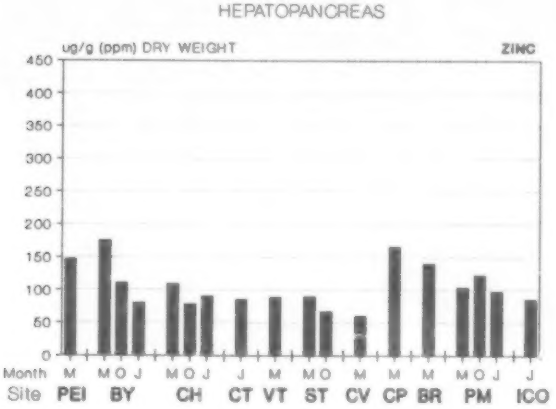


FIGURE 3H TRACE METAL CONCENTRATIONS IN DUNGNESS CRAB (*Cancer magister*) MUSCLE, HEPATOPANCREAS, AND GILL TISSUE - VANCOUVER HARBOUR (1985-1986) - LEAD


DUNGENESS CRAB
MUSCLE


HEPATOPANCREAS

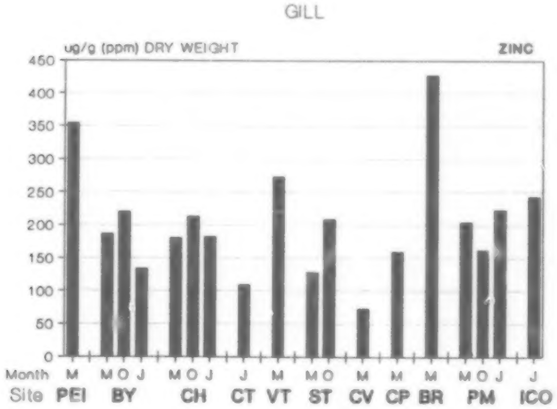

GILL

FIGURE 3I TRACE METAL CONCENTRATIONS IN DUNGENESS CRAB (*Cancer magister*) MUSCLE, HEPATOPANCREAS, AND GILL TISSUE - VANCOUVER HARBOUR (1985-1986) - ZINC

FIGURE 4

TRACE METAL CONCENTRATIONS IN ENGLISH SOLE (*Parophyrys vetulus*) MUSCLE, LIVER AND GILL TISSUE - VANCOUVER HARBOUR (1985-1986)

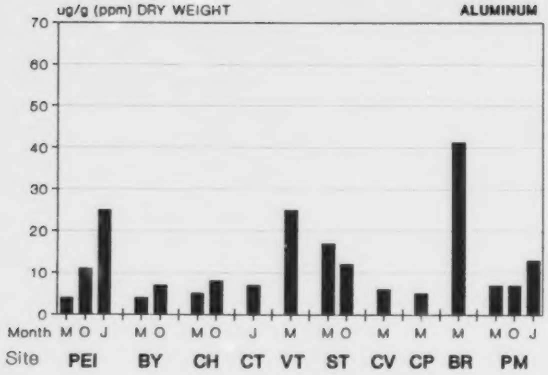
LEGEND

(a) Aluminium
(b) Arsenic
(c) Cadmium
(d) Chromium
(e) Copper
(f) Iron
(g) Mercury
(h) Lead
(i) Zinc

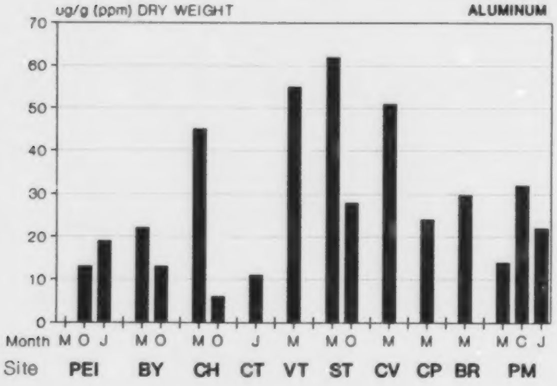
PEI = Pacific Environment Institute
BY = Burrard Yarrows
CH = Coal Harbour
CT = Centre
VT = Vanterm
ST = Sterling
CV = Chevron
CP = Cates Park
BR = Boulder Rock
PM = Port Moody (Trawls 1 and 2)

M = May 1985
O = October 1985
J = January 1986

ENGLISH SOLE
MUSCLE



LIVER



GILL

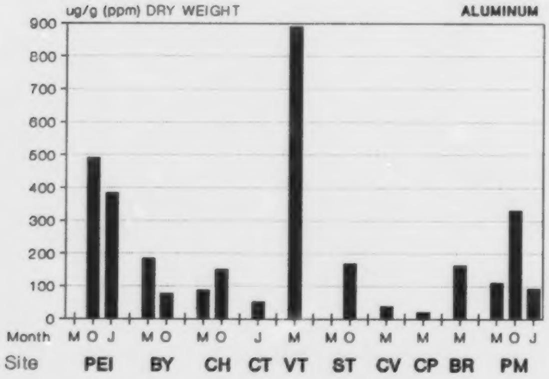
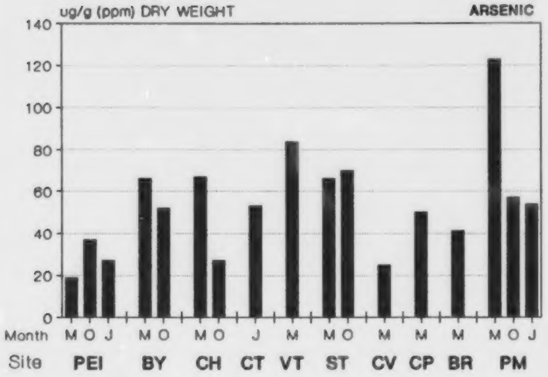
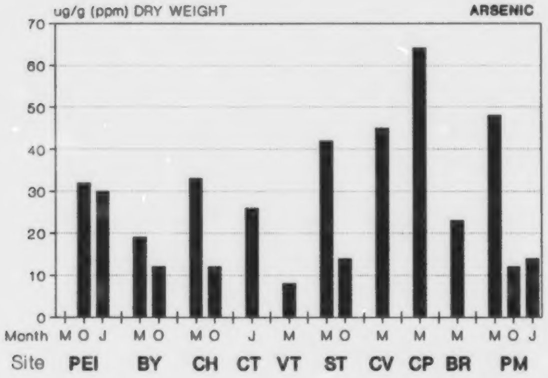


FIGURE 4A TRACE METAL CONCENTRATIONS IN ENGLISH SOLE (*Parophyrys vetulus*) MUSCLE, LIVER, AND GILL TISSUE - VANCOUVER HARBOUR (1985-1986) - ALUMINUM

ENGLISH SOLE
MUSCLE



LIVER



GILL

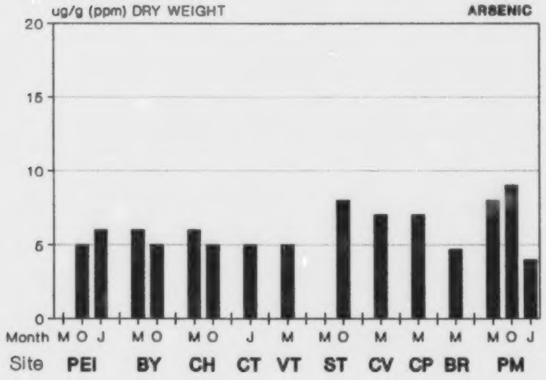
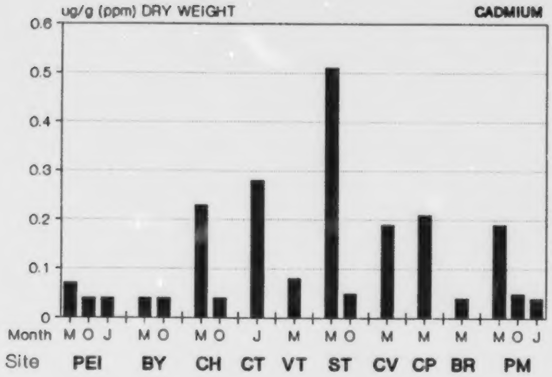
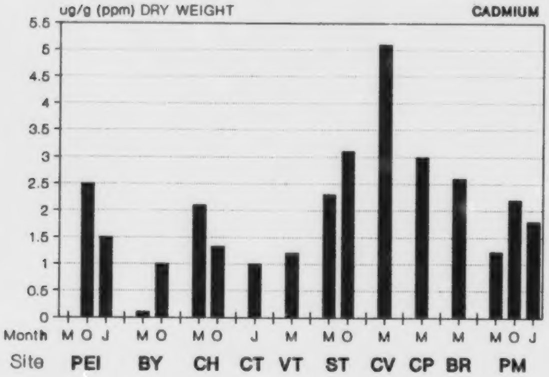


FIGURE 4B TRACE METAL CONCENTRATIONS IN ENGLISH SOLE (*Parophyrys vetulus*) MUSCLE, LIVER, AND GILL TISSUE - VANCOUVER HARBOUR (1985-1986) - ARSENIC

ENGLISH SOLE
MUSCLE



LIVER



GILL

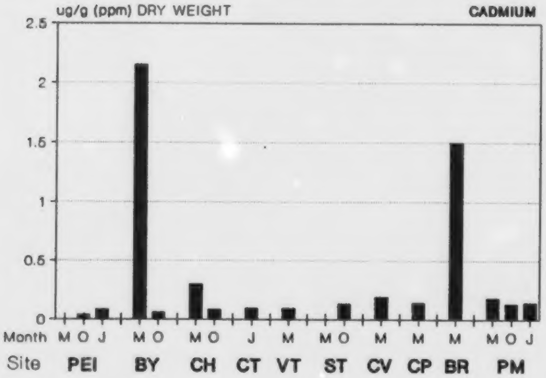
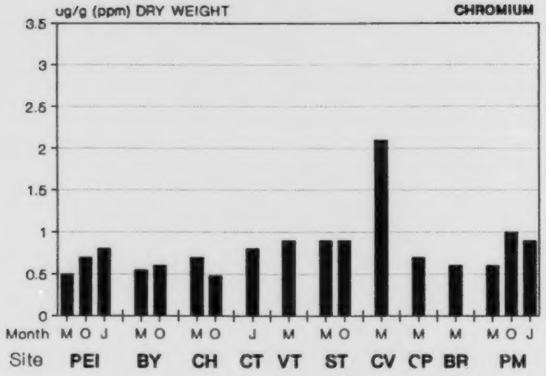
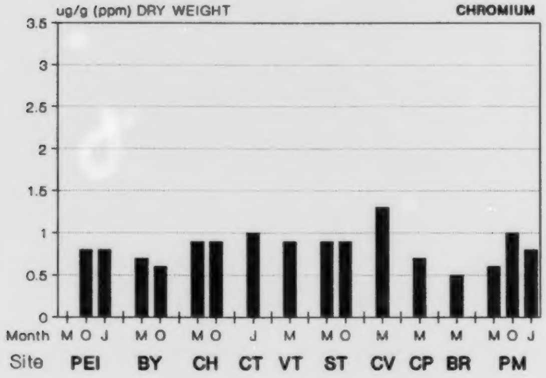


FIGURE 4C TRACE METAL CONCENTRATIONS IN ENGLISH SOLE (*Parphyrys vetulus*) MUSCLE, LIVER, AND GILL TISSUE - VANCOUVER HARBOUR (1985-1986) - CADMIUM

ENGLISH SOLE
MUSCLE



LIVER



GILL

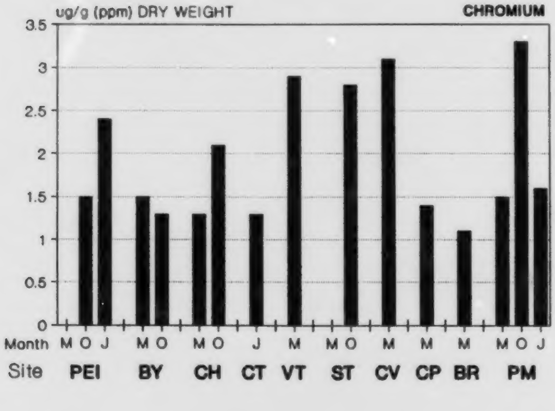
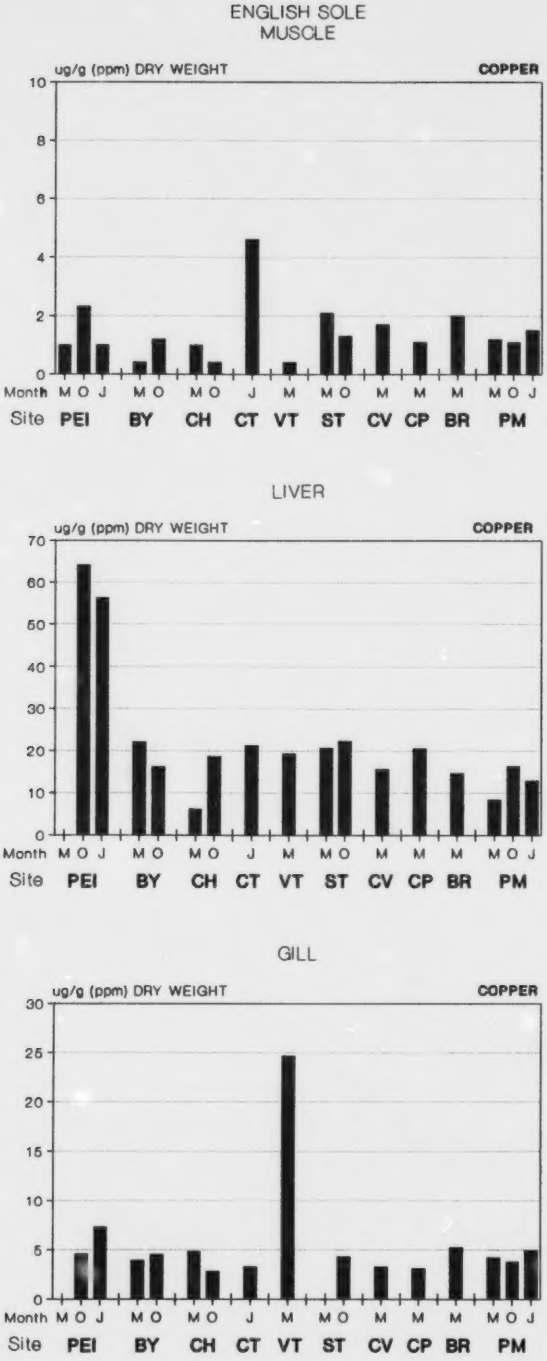


FIGURE 4D TRACE METAL CONCENTRATIONS IN ENGLISH SOLE (*Parophyrys vetulus*) MUSCLE, LIVER, AND GILL TISSUE - VANCOUVER HARBOUR (1985-1986) - CHROMIUM


ENGLISH SOLE

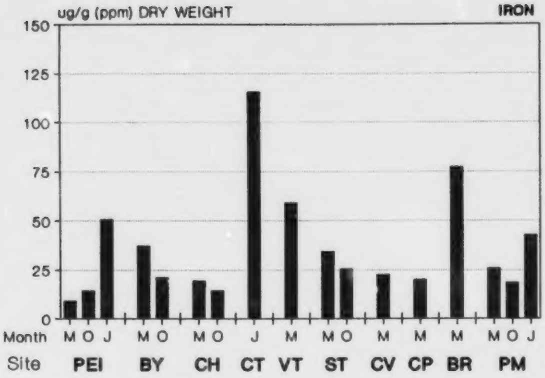
MUSCLE

LIVER

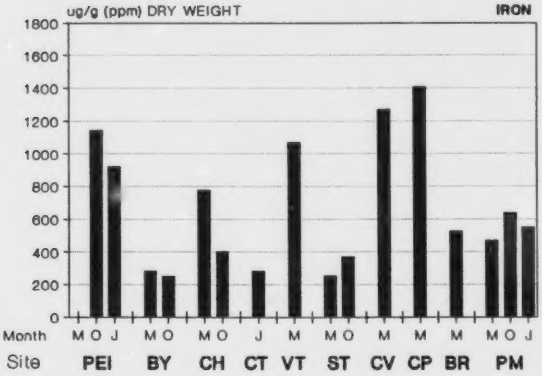
GILL

FIGURE 4E TRACE METAL CONCENTRATIONS IN ENGLISH SOLE (*Parophyrys vetulus*) MUSCLE, LIVER, AND GILL TISSUE - VANCOUVER HARBOUR (1985-1986) - COPPER

ENGLISH SOLE
MUSCLE



LIVER



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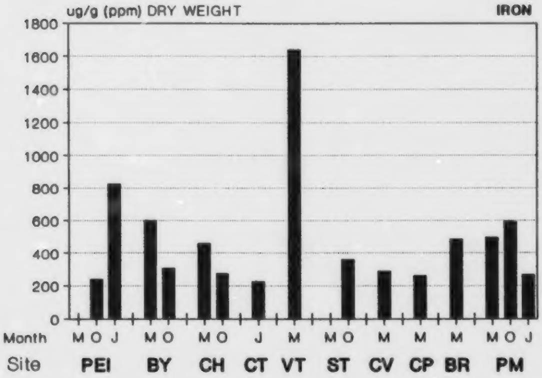
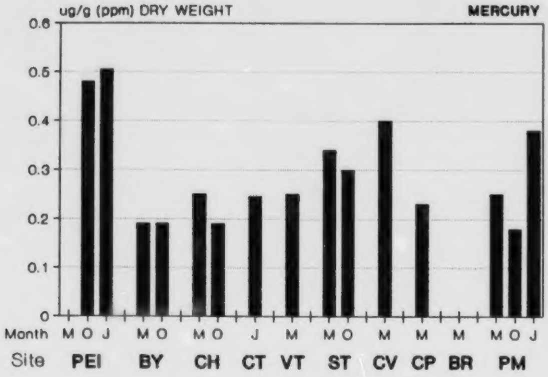
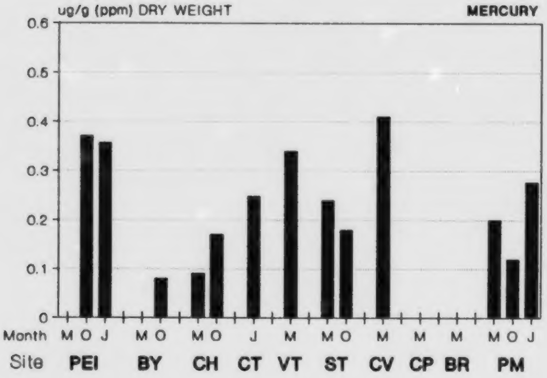


FIGURE 4F TRACE METAL CONCENTRATIONS IN ENGLISH SOLE (*Parophyrys vetulus*) MUSCLE, LIVER, AND GILL TISSUE - VANCOUVER HARBOUR (1985-1986) - IRON

ENGLISH SOLE
MUSCLE



LIVER



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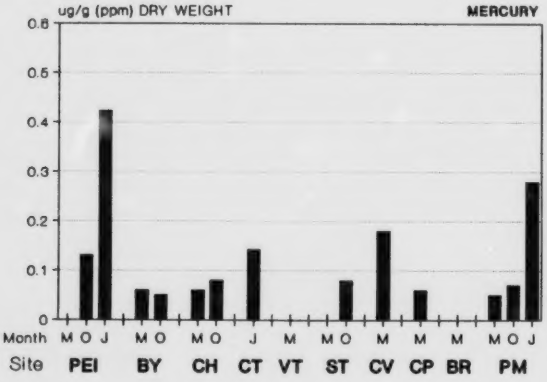
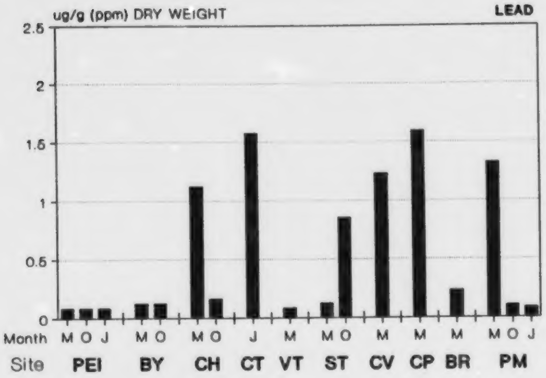
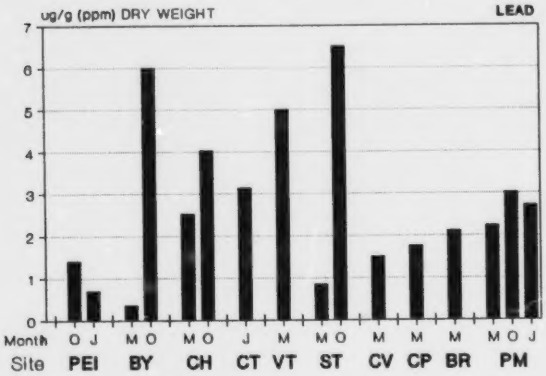


FIGURE 4G TRACE METAL CONCENTRATIONS IN ENGLISH SOLE (*Parophyrys vetulus*) MUSCLE, LIVER, AND GILL TISSUE - VANCOUVER HARBOUR (1985-1986) - MERCURY

ENGLISH SOLE
MUSCLE



LIVER



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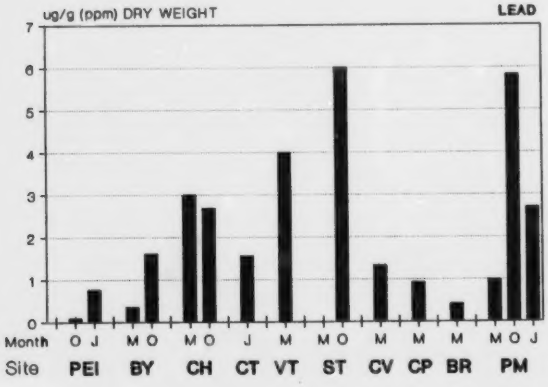
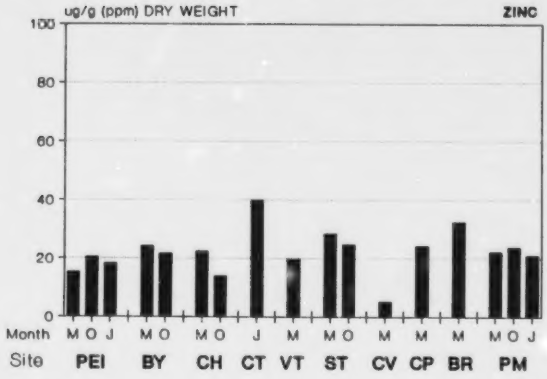
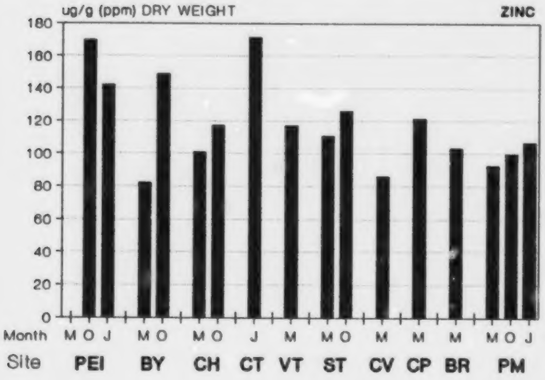


FIGURE 4H TRACE METAL CONCENTRATIONS IN ENGLISH SOLE (*Parophyrys vetulus*) MUSCLE, LIVER, AND GILL TISSUE - VANCOUVER HARBOUR (1985-1986) - LEAD

ENGLISH SOLE
MUSCLE



LIVER



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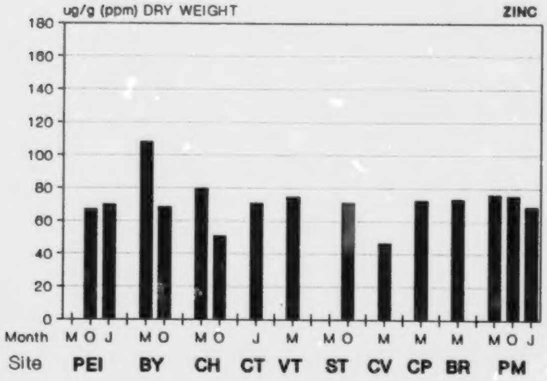

FIGURE 4I TRACE METAL CONCENTRATIONS IN ENGLISH SOLE (Parophyrys vetulus) MUSCLE, LIVER, AND GILL TISSUE - VANCOUVER HARBOUR (1985-1986) - ZINC

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APPENDIX I

COORDINATES AND DEPTHS FOR OTTER TRAWL SURVEYS IN VANCOUVER HARBOUR

(1985 - 1986)

APPENDIX I - COORDINATES AND DEPTHS FOR OTTER TRAWL SURVEYS IN VANCOUVER HARBOUR (1985-1986)

SURVEY DATE	STATION	START			FINISH		
		DEPTH	LATITUDE	LONGITUDE	DEPTH	LATITUDE	LONGITUDE
MAY 1985	PEI	62	49°19.87'N	123°13.65'W	37	49°19.20'N	123°12.88'W
	BURRARD YARROWS	18	49°18.08'N	123°03.92'W	22	49°18.23'N	123°04.23'W
	COAL HARBOUR	26	49°17.45'N	123°05.82'W	13	49°17.59'N	123°06.68'W
	STERLING	33	49°17.68'N	123°03.51'W	26	49°18.18'N	123°04.20'W
	CHEVRON	37	49°17.71'N	123°00.75'W	37	49°17.80'N	123°59.40'W
	CATES PARK	33	49°18.05'N	122°55.17'W	26	49°17.85'N	122°57.35'W
	BOULDER ROCK	26	49°17.97'N	122°56.79'W	33	49°18.31'N	122°56.26'W
	PORT MOODY	15	49°17.65'N	122°53.42'W	15	49°17.55'N	122°54.18'W
OCTOBER 1985	PEI	68	49°19.77'N	123°14.29'W	55	49°19.78'N	123°13.55'W
	BURRARD YARROWS	23	49°18.08'N	123°04.50'W	24	49°18.18'N	123°04.77'W
	COAL HARBOUR	20	49°17.46'N	123°05.87'W	13	49°17.52'N	123°06.64'W
	STERLING	24	49°17.52'N	123°04.05'W	32	49°17.74'N	123°03.39'W
	PORT MOODY	15	49°17.66'N	122°53 45'W	16	49°17.55'N	122°54.20'W
JANUARY 1986	PEI	66	49°19.76'N	123°14.39'W	56	49°19.75'N	123°13.67'W
	BURRARD YARROWS	27	49°18.23'N	123°05.26'W	25	49°18.25'N	123°04.47'W
	COAL HARBOUR	21	49°17.49'N	123°06.10'W	12	49°17.53'N	123°06.76'W
	CENTRE	31	49°17.93'N	123°04.67'W	36	49°18.16'N	123°05.40'W
	PORT MOODY	14	49°17.60'N	122°53.68'W	17	49°17.52'N	122°54.45'W
	IOCO	13	49°17.75'N	122°53.61'W	10	49°17.94'N	122°52.90'W

APPENDIX II

TISSUE TRACE METAL CONCENTRATIONS - RAW DATA

VANCOUVER HARBOUR (1985-1986)

A. MAY 1985

B. OCTOBER 1985

C. JANUARY 1986

APPENDIX IIA Tissue Trace Metal Concentrations - Raw Data - Vancouver Harbour, May 1985.

Station	Concentration (μg/g dry weight)													
	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
SHRIMP														
PACIFIC ENVIRONMENT INSTITUTE (PEI)														
PINK SHRIMP (Pandalus borealis) - MUSCLE														
	13.0	47.0	0.12	1.50	<0.4	12.6	35.8	-	1380	1.71	<0.4	<2.0	0.10	46.2
	9.0	34.0	0.12	0.35	<0.4	14.0	32.4	-	1420	1.45	<0.4	<2.0	0.20	44.8
	7.0	50.0	<0.08	0.07	0.7	12.5	23.7	-	1510	1.29	<0.4	<2.0	0.10	47.6
	26.0	40.0	0.17	0.11	<0.4	12.0	64.6	-	1410	1.70	<0.4	<2.0	0.17	42.0
	8.0	34.0	0.10	1.12	0.5	14.0	28.7	-	1410	1.35	<0.4	<2.0	<0.08	45.7
	7.0	41.0	0.16	0.10	0.5	24.3	29.3	-	1400	1.25	<0.4	<2.0	<0.08	49.6
	<4.0	45.0	0.11	0.11	<0.4	11.8	21.1	-	1390	1.14	<0.4	<2.0	<0.08	42.4
	45.0	51.0	0.51	0.11	<0.4	13.7	82.0	-	1550	2.25	<0.4	<2.0	<0.08	49.0
	32.0	41.0	0.22	0.09	0.5	13.3	56.6	-	1410	1.61	<0.4	<2.0	<0.08	43.3
	24.0	43.0	0.16	0.09	0.5	13.9	56.1	-	1370	1.54	<0.4	<2.0	<0.08	45.5
	27.0	34.0	0.18	0.11	<0.4	12.5	56.4	-	1500	1.60	<0.4	<2.0	<0.08	44.3
	24.0	33.0	0.21	0.09	0.8	14.9	63.1	-	1400	1.79	<0.4	<2.0	0.19	44.6
	<4.0	38.0	0.08	0.15	<0.4	12.4	17.0	-	1520	1.33	<0.4	<2.0	<0.08	44.7
	<4.0	36.0	<0.08	0.07	0.6	12.4	11.7	-	1500	1.41	0.6	<2.0	<0.08	43.7
	8.0	48.0	0.10	0.09	0.5	13.0	27.9	-	1470	1.23	<0.4	<2.0	<0.08	45.0
	<4.0	50.0	0.54	0.10	0.5	11.8	8.2	-	1540	1.23	0.4	<2.0	<0.08	45.7
	4.0	43.0	<0.08	0.32	<0.4	14.8	25.1	-	1530	1.57	<0.4	<2.0	0.09	49.5
	<4.0	38.0	<0.08	0.31	<0.4	14.3	20.7	-	1520	1.46	<0.4	<2.0	0.09	46.5
	<4.0	37.0	<0.08	0.08	0.5	16.9	10.0	-	1540	1.61	<0.4	<2.0	<0.08	45.0
	6.0	45.0	0.08	0.21	0.6	13.4	25.1	-	1640	1.61	<0.4	<2.0	<0.08	48.2
	<4.0	36.0	<0.08	0.11	0.4	13.0	10.1	-	1460	0.97	<0.4	<2.0	<0.08	45.7
	16.0	54.0	0.15	0.71	0.4	13.3	43.0	-	1560	1.77	<0.4	<2.0	<0.08	49.5
	<4.0	42.0	<0.08	0.11	<0.4	12.0	9.0	-	1480	1.05	<0.4	<2.0	<0.08	44.8
	<4.0	43.0	0.08	0.17	<0.4	12.9	10.0	-	1530	1.17	<0.4	<2.0	<0.08	46.0
	8.0	44.0	0.13	0.11	0.4	14.6	28.1	-	1620	1.40	<0.4	<2.0	<0.08	46.6
	<4.0	31.0	0.09	0.17	0.5	18.0	13.7	-	1530	1.59	0.6	<2.0	<0.08	47.6
	<4.0	52.0	0.36	0.08	<0.4	17.3	14.9	-	1780	1.50	<0.4	<2.0	<0.08	51.0
	<4.0	40.0	0.10	0.12	<0.4	18.2	10.5	-	1590	1.47	<0.4	<2.0	<0.08	50.6

APPENDIX IIA Tissue Trace Metal Concentrations - Raw Data - Vancouver Harbour, May 1985.

Station	Concentration (µg/g dry weight)													
	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
- HEPATOPANCREAS														
	24.0	31.0	0.29	12.00	0.5	1250.0	255.0	-	667	11.10	0.8	<2.0	0.14	84.1
	267.0	27.0	1.38	9.10	1.0	1170.0	770.0	-	885	17.20	0.6	<2.0	0.43	86.5
	23.0	28.0	0.27	6.90	<0.4	1060.0	224.0	-	599	8.02	0.9	<2.0	0.11	80.8
	25.0	31.0	0.33	9.70	1.0	1140.0	280.0	-	498	8.86	1.2	<2.0	<0.08	86.6
	37.0	28.0	0.35	9.80	0.4	1250.0	197.0	-	601	8.89	1.1	<2.0	0.27	88.1
	35.0	30.0	0.40	8.80	0.7	1000.0	313.0	-	724	10.30	1.6	<2.0	0.18	94.0
	6.0	32.0	0.20	9.40	<0.4	1510.0	231.0	-	732	9.90	1.1	<2.0	0.17	110.0
	<4.0	36.0	0.49	12.00	0.5	1760.0	245.0	-	831	10.60	1.4	<2.0	0.13	109.0
	<4.0	38.0	0.18	7.30	<0.4	1240.0	229.0	-	569	7.49	0.7	<2.0	1.34	86.5
	63.0	20.0	0.70	8.90	0.5	1500.0	381.0	-	716	10.60	1.1	<2.0	0.33	90.8
	24.0	32.0	0.35	9.40	0.5	1380.0	258.0	-	767	9.70	0.8	<2.0	0.11	106.0
	6.0	21.0	0.18	11.20	<0.4	919.0	167.0	-	399	6.01	<0.4	<2.0	0.18	74.7
COONSTRIPE SHRIMP (Pandalus danae) - MUSCLE														
	19.0	24.0	0.75	0.06	0.5	12.4	37.0	-	1440	1.49	<0.4	<2.0	<0.08	49.1
	15.0	15.0	0.13	1.40	0.4	10.5	35.4	-	1330	1.51	<0.4	<2.0	0.09	45.3
PRAWN (Pandalus platyceros) - MUSCLE														
	9.0	22.0	0.10	0.08	<0.4	15.2	28.8	-	1450	1.42	<0.4	<2.0	0.13	44.5
	18.0	17.0	0.32	0.18	0.4	14.2	48.5	-	1580	1.54	<0.4	<2.0	<0.08	47.9
	<4.0	35.0	<0.08	0.09	0.5	16.8	18.3	-	1350	1.03	<0.4	<2.0	0.08	45.0
- HEPATOPANCREAS														
	16.0	22.0	0.29	3.30	0.4	1110	558	-	590	10.40	<0.4	5.0	0.16	101.0
	400.0	40.0	3.80	3.90	3.0	1140	2030	-	1660	27.00	<1.0	<5.0	0.80	159.0
COAL HARBOUR (CH)														
PINK SHRIMP (Pandalus borealis) - MUSCLE														
	29	23	0.17	0.25	0.4	14.6	54.4	0.17	1550	1.64	<0.4	<2	1.01	56.0
	32	21	0.29	0.26	0.7	12.0	72.8	0.15	1500	1.72	<0.4	<2	1.03	50.7

APPENDIX IIA Tissue Trace Metal Concentrations - Raw Data - Vancouver Harbour, May 1985.

Station	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
						Concentration (µg/g dry weight)								
- MUSCLE (continued)														
	14	25	0.12	0.23	0.4	8.6	38.7	0.24	1490	1.04	<0.4	<2	1.03	48.8
	53	24	0.36	0.26	0.8	13.5	111.0	0.69	1520	2.07	<0.4	<2	1.21	52.9
	30	25	0.38	0.24	0.5	13.1	68.8	0.29	1640	1.91	<0.4	<2	0.96	50.3
	27	32	0.23	0.24	1.0	9.2	63.5	0.30	1420	1.42	<0.4	<2	0.97	49.2
- HEPATOPANCREAS														
	25	23	0.79	4.10	0.9	1280.0	234.0	0.26	866	11.00	1.9	<2	0.76	106.0
	329	19	2.10	4.90	1.1	725.0	681.0	-	990	15.40	2.8	<2	1.70	93.1
	25	38	0.30	2.90	0.9	568.0	211.0	0.18	610	7.60	1.1	<2	0.50	89.9
	31	39	0.38	6.50	0.9	1030.0	245.0	0.41	659	10.40	1.6	<2	1.03	111.0
	26	30	0.30	4.40	0.6	689.0	237.0	0.30	710	9.30	1.2	<2	0.70	89.4
	325	28	1.70	4.60	1.4	655.0	736.0	0.31	1180	19.00	3.0	2	1.50	109.0
HUMPBACK SHRIMP (Pandalus hypsinotus) - MUSCLE														
	26	22	0.09	0.28	0.6	8.6	54.3	0.18	1480	0.97	<0.4	<2	0.93	46.0
	9	17	<0.08	0.30	<0.4	9.0	25.5	0.26	1530	0.69	<0.4	<2	0.93	37.3
	90	28	4.56	0.34	0.6	19.6	189.0	0.20	1630	1.68	<0.4	<2	1.32	63.6
	46	35	0.19	0.27	1.1	15.9	129.0	0.28	1850	1.99	<0.4	<2	1.57	63.6
	37	21	0.35	0.25	0.7	17.5	74.4	0.16	1510	1.61	<0.4	<2	1.08	62.4
	41	22	0.34	0.30	0.8	21.5	92.2	0.11	1560	1.83	<0.4	<2	0.96	66.2
	36	29	0.25	0.31	1.0	15.9	81.0	0.21	1970	1.67	<0.4	3	1.10	60.5
	21	25	0.18	0.24	0.6	15.9	48.5	0.27	1600	1.38	<0.4	<2	1.04	58.3
	33	24	0.21	0.18	0.8	20.6	79.6	0.10	1510	1.52	<0.4	<2	0.95	64.1
	21	29	0.12	0.18	0.6	19.6	41.4	0.27	1480	1.25	<0.4	<2	0.96	64.6
	36	30	0.24	0.25	0.7	16.4	80.4	0.15	1430	1.70	<0.4	<2	0.95	58.4
	38	24	0.23	0.31	0.7	13.4	89.9	0.15	1650	1.30	<0.4	<2	0.99	44.7
- HEPATOPANCREAS														
	120	24	0.65	3.90	0.8	324.0	374.0	0.11	658	8.79	1.6	2	0.82	83.1
	29	20	0.27	6.00	0.6	662.0	183.0	-	582	8.00	1.2	2	0.80	102.0

APPENDIX IIA Tissue Trace Metal Concentrations - Raw Data - Vancouver Harbour, May 1985.

Station	Concentration (µg/g dry weight)													
	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
- HEPATOPANCREAS (continued)														
	46	28	0.50	3.00	0.9	506.0	278.0	0.12	530	8.30	1.5	<2	1.30	82.4
	35	26	0.34	5.10	0.6	562.0	360.0	0.13	607	8.87	1.8	2	1.70	95.5
	25	33	0.24	6.50	0.7	620.0	315.0	0.13	705	9.76	1.6	2	0.64	121.0
	15	26	0.21	4.10	0.5	498.0	417.0	0.09	611	7.47	2.2	2	0.62	95.7
COONSTRIPE SHRIMP (Pandalus danae) - MUSCLE														
	25	19	0.23	0.25	0.7	14.4	60.4	0.15	1530	1.61	<0.4	<2	0.98	55.2
	27	22	0.18	0.28	0.6	18.2	55.0	0.22	1530	1.80	<0.4	<2	1.01	60.1
	14	23	0.13	0.26	0.6	17.0	35.0	0.81	1520	1.29	<0.4	<2	1.14	56.6
	54	20	0.19	0.33	0.5	19.8	88.0	0.44	1640	2.21	<0.4	<2	1.00	60.7
	21	21	0.14	0.27	0.5	14.9	51.9	0.48	1620	1.20	<0.4	<2	0.99	51.4
	20	24	0.13	0.27	0.5	19.7	44.5	0.61	1460	1.40	<0.4	<2	0.98	62.7
- HEPATOPANCREAS														
	88	39	0.80	7.50	0.9	1090.0	733.0	0.29	1050	14.60	2.3	2	1.40	129.0
	47	41	0.47	7.50	0.8	1540.0	665.0	0.28	784	12.20	2.4	<2	1.44	139.0
	9	31	0.32	5.60	0.8	1100.0	535.0	0.19	631	8.66	2.0	<2	1.33	103.0
	17	28	0.40	14.40	0.9	1710.0	592.0	0.43	860	13.40	2.2	<2	1.40	142.0
	14	24	0.30	6.50	1.0	1120.0	968.0	0.24	570	9.60	2.8	<2	1.90	102.0
	252	40	1.72	6.00	1.1	1250.0	1350.0	0.20	956	17.50	3.0	<2	1.57	117.0
CRANGON SHRIMP (Crangon communis) - MUSCLE														
	108	10	0.86	0.31	1.1	40.6	258.0	0.16	1410	4.18	<0.4	<2	1.13	94.4
	124	12	0.73	0.27	0.9	28.7	364.0	0.08	1390	3.91	0.7	<2	1.49	77.4
	74	11	0.56	0.27	0.6	31.6	162.0	0.07	1460	2.82	<0.4	<2	1.10	77.0
STERLING (ST)														
COONSTRIPE SHRIMP (Pandalus danae) - MUSCLE														
	5	16	0.10	0.06	0.5	18.6	20.6	0.31	1550	0.99	0.5	<2	<0.08	51.2
	12	28	0.11	0.06	0.4	16.7	22.2	0.22	1720	1.15	<0.4	<2	0.13	58.4

APPENDIX IIA **Tissue Trace Metal Concentrations - Raw Data - Vancouver Harbour, May 1985.**

	Concentration (μg/g dry weight)													
Station	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
- MUSCLE (continued)														
	10	19	0.1	<0.04	0.4	16.4	23	0.13	1630	1.18	<0.4	<2	0.1	51.9
	27	22	0.18	<0.04	0.7	13.3	46.6	0.15	1700	1.56	<0.4	<2	<0.08	57.2
	<4	20	0.15	0.05	0.5	22.1	16.0	0.18	1730	1.15	<0.4	<2	<0.08	56.5
	6	19	0.14	0.04	0.5	18.5	20.7	0.19	1550	1.38	<0.4	<2	<0.08	58.1
	<4	19	0.27	<0.04	0.5	18.6	19.1	0.12	1690	1.27	<0.4	<2	<0.08	55.8
	<4	22	0.11	<0.04	<0.4	17.0	12.2	0.13	1520	1.24	<0.4	<2	<0.08	56.4
	<4	25	0.14	0.05	0.4	19.9	14.8	0.19	1650	1.59	<0.4	<2	<0.08	55.3
	8	29	0.11	0.05	0.4	15.7	20.5	0.37	1680	1.27	0.4	<2	<0.08	54.9
	5	27	<0.08	<0.04	<0.4	18.3	10.1	0.30	1630	0.95	<0.4	<2	<0.08	51.6
- HEPATOPANCREAS														
	27	45	0.4	9.3	0.7	1360	840	0.17	1130	12.8	2.4	<2	0.30	121
	6	34	0.5	11.7	0.7	1020	594	0.18	930	11.8	2.2	<2	0.40	114
CHEVRON (CV)														
COONSTRIPE SHRIMP (_Pandalus danae_) - MUSCLE														
	<4	23	0.09	0.18	1.6	21.3	13.4	0.35	1450	0.99	<0.4	<2	1.19	59.8
	<4	18	0.10	0.18	2.3	16.8	12.6	0.17	1410	1.12	<0.4	<2	1.19	64.2
	<4	24	0.10	0.18	2.1	14.4	11.2	0.16	1480	0.97	<0.4	<2	1.14	57.5
	<5	18	0.11	0.16	2.3	14.7	12.2	0.11	1470	0.90	<0.5	<2	1.10	57.1
	<4	27	<0.08	0.18	2.2	16.8	15.1	0.18	1470	1.14	<0.4	<2	1.28	41.7
	<4	22	0.25	0.16	1.1	18.7	16.1	0.19	1460	1.07	<0.4	<2	1.25	44.8
	<4	17	<0.08	0.16	1.2	16.8	13.1	0.27	1420	1.06	<0.4	<2	1.34	43.5
	<4	28	<0.08	0.16	1.0	17.9	12.4	0.17	1400	0.97	<0.4	<2	1.13	41.9
	<4	30	<0.08	0.16	0.9	19.1	13.3	0.14	1420	1.02	<0.4	<2	1.21	50.6
	<4	25	<0.08	0.18	1.2	15.0	8.2	0.15	1520	0.97	<0.4	<2	1.30	40.0
	<8	20	<0.20	0.14	1.3	18.3	25.9	0.18	1480	1.20	<0.8	<3	1.00	<0.3
	<4	20	<0.08	0.16	1.4	17.8	23.2	0.13	1490	1.21	<0.4	<2	1.25	25.9

APPENDIX IIA Tissue Trace Metal Concentrations - Raw Data - Vancouver Harbour, May 1985.

	Concentration (µg/g dry weight)													
Station	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
- HEPATOPANCREAS														
	10	68	0.30	11.00	1.8	704.0	328.0	0.05	770	15.10	1.7	<3	1.00	80.1
	53	76	0.70	8.10	4.1	799.0	440.0	0.08	670	13.30	1.9	<3	1.20	58.3
	8	58	0.40	10.60	2.4	687.0	255.0	0.05	850	15.50	1.4	<3	1.00	104.0
	<8	68	0.40	14.90	6.1	827.0	353.0	0.06	830	16.50	1.7	<3	1.30	87.5
	<7	75	0.50	11.40	2.2	948.0	235.0	0.04	1000	15.30	2.3	<3	1.20	82.7
	<4	59	0.25	7.90	1.1	795.0	287.0	0.07	724	12.10	1.9	<2	1.02	95.3
CATES PARK (CP)														
COONSTRIPE SHRIMP (*Pandalus danae*) - MUSCLE														
	<4	21	0.08	0.28	0.4	15.3	24.2	0.02	1710	1.21	<0.4	<2	1.44	55.5
	7	10	0.35	0.18	0.4	20.5	39.5	0.13	1840	1.51	<0.4	<2	1.29	54.6
	8	15	0.10	0.18	<0.4	17.6	34.6	0.05	1660	1.56	<0.4	<2	1.45	56.5
	12	19	0.18	0.18	0.5	22.4	41.8	0.08	1800	1.62	<0.4	<2	1.57	55.2
	9	21	0.17	0.18	0.6	17.6	62.5	0.06	1770	1.56	<0.4	<2	1.51	53.9
	10	19	0.16	0.18	0.5	22.1	35.6	0.04	1700	1.69	<0.4	<2	1.33	60.9
- HEPATOPANCREAS														
	<7	33	0.60	6.10	0.8	1040.0	613	0.06	1230	15.3	1.7	<3	1.40	106.0
	17	24	0.70	6.00	<0.7	879.0	827	-	1660	14.2	2.1	<3	1.60	125.0
BOULDER ROCK (BR)														
HUMPBACK SHRIMP (*Pandalus hypsinotus*) - MUSCLE														
	<4.0	33.0	0.09	0.06	0.4	15.2	17.9	-	1420	1.15	<0.4	<2.0	0.12	50.4
	19.0	16.0	0.33	0.05	0.5	17.6	35.4	-	1690	1.54	<0.4	<2.0	0.12	54.4
	37.0	20.0	0.26	0.06	<0.4	23.1	68.3	-	1470	1.84	<0.4	2.0	0.20	55.9
	7.0	16.0	0.11	0.04	0.5	14.4	23.4	-	1400	1.09	<0.4	<2.0	0.09	48.9
	<4.0	17.0	0.08	<0.04	0.6	15.1	9.9	-	1340	1.04	<0.4	3.0	0.09	56.0
	35.0	16.0	0.29	0.05	0.5	14.8	62.7	-	1480	1.61	<0.4	2.0	0.14	52.0
	33.0	18.0	0.49	0.05	<0.4	15.4	47.1	-	1930	1.74	<0.4	<2.0	0.09	63.9
	12.0	16.0	0.30	0.06	<0.5	16.7	29.0	-	1630	1.40	<0.5	<2.0	0.20	58.3

APPENDIX IIA Tissue Trace Metal Concentrations - Raw Data - Vancouver Harbour, May 1985.

Station	Concentration (µg/g dry weight)													
	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
- HEPATOPANCREAS														
	45.0	21.0	0.50	1.9	0.6	1170.0	316.0	-	780.0	12.1	0.9	10.0	4.0	118.0
	25.0	33.0	0.30	2.5	0.5	981.0	304.0	-	690.0	12.3	0.7	4.0	0.3	117.0
COONSTRIPE SHRIMP (Pandalus danae) - MUSCLE														
	38.0	16.0	0.27	0.07	0.9	27.2	69.8	-	1600	2.02	<0.4	3.0	0.16	57.7
	48.0	16.0	0.31	0.35	0.8	25.6	99.1	-	1680	2.01	<0.4	2.0	0.26	58.9
	25.0	18.0	0.22	0.07	0.7	24.1	53.4	-	1580	1.71	<0.4	3.0	3.00	55.2
	17.0	33.0	0.13	0.05	0.5	18.8	37.9	-	1550	1.42	<0.4	<2.0	0.13	53.0
	18.0	17.0	0.16	0.06	0.6	20.9	43.3	-	1530	1.51	<0.4	<2.0	0.13	55.6
	25.0	31.0	0.24	0.05	0.6	19.4	47.5	-	1570	1.51	<0.4	<2.0	3.00	53.2
- HEPATOPANCREAS														
	43.0	33.0	0.5	2.5	0.7	834.0	564.0	-	1110	14.9	1.7	5.0	3.0	121.0
	20.0	50.0	0.3	3.3	<1.0	1590.0	719.0	-	1050	14.3	<1.0	6.0	1.1	144.0
PORT MOODY (PM)														
COONSTRIPE SHRIMP (Pandalus danae) - MUSCLE														
	6	17	0.36	0.20	0.5	19.0	17.6	0.06	1680	1.37	<0.4	<2	1.44	58.7
	9	27	0.12	0.22	0.4	20.7	23.5	0.12	1690	1.08	<0.4	<2	1.44	63.4
	47	19	0.27	0.22	0.6	24.1	55.2	0.09	1920	1.39	<0.4	<2	1.44	65.1
	29	19	0.24	0.24	0.6	21.1	55.0	0.25	1850	1.44	<0.4	<2	1.27	63.6
	19	22	0.14	0.19	0.7	21.1	35.4	0.24	1660	1.23	<0.4	<2	1.36	59.9
	13	20	0.19	0.19	0.6	18.5	28.4	0.08	1650	1.22	<0.4	<2	1.51	57.7
- HEPATOPANCREAS														
	40	20	1.20	2.40	1.0	1240.0	493.0	0.05	760	11.30	3.0	<5	0.50	122.0
	60	10	0.50	1.50	<1.0	1410.0	493.0	0.05	750	12.00	2.0	<5	0.50	117.0
	50	40	1.10	2.30	1.0	1400.0	906.0	-	990	14.10	2.0	<5	1.10	130.0

APPENDIX IIA **Tissue Trace Metal Concentrations - Raw Data - Vancouver Harbour, May 1985.**

	Concentration (µg/g dry weight)													
Station	**Al**	**As**	**Ba**	**Cd**	**Cr**	**Cu**	**Fe**	**Hg**	**Mg**	**Mn**	**Mo**	**Ni**	**Pb**	**Zn**
CRAB - MAY 1985														
PACIFIC ENVIRONMENT INSTITUTE (PEI)														
DUNGENESS CRAB (Cancer magister) - MUSCLE														
	24.0	95.0	0.25	0.07	0.6	27.3	94.1	-	1530	1.61	<0.4	<2.0	0.13	190.0
	36.0	64.0	0.51	0.12	0.9	45.9	121.0	-	1670	4.31	<0.4	<2.0	<0.08	215.0
	20.0	33.0	0.29	0.08	<0.4	34.3	75.5	-	1700	2.38	<0.4	<2.0	0.16	216.0
- HEPATOPANCREAS														
	26.0	30.0	0.97	6.10	1.2	357.0	367.0	-	2830	11.20	1.0	<2.0	0.28	127.0
	29.0	21.0	0.58	0.16	0.6	19.9	145.0	-	611	8.01	<0.4	<2.0	0.44	168.0
- GILL														
	539.0	24.0	7.09	0.75	2.1	172	1770	-	3060	19.70	<0.4	3.0	0.54	196.0
	2590.0	30.0	20.60	1.50	10.1	221	8490	-	5790	73.50	<0.4	10.0	5.05	437.0
	219.0	34.0	4.14	1.40	1.2	308	1040	-	2480	14.40	<0.4	3.0	0.09	430.0
BURRARD YARROWS (BY)														
DUNGENESS CRAB (Cancer magister) - MUSCLE														
	9	19	0.17	<0.04	0.4	32.8	46.1	0.11	1490	1.13	<0.4	<2	0.1	224.0
- HEPATOPANCREAS														
	<4	11	0.26	0.08	0.5	8.7	83.3	<0.02	362	6.16	<0.4	<2	0.68	175.0
- GILL														
	121	18	3.56	0.5	1.2	233.0	853.0	0.06	4140	6.47	1.3	<2	8.0	187.0
COAL HARBOUR (CH)														
TANNER CRAB (Chionocetes bairdi) - MUSCLE														
	33	28	0.24	0.23	0.8	18.7	79.5	0.47	2310	1.57	<0.4	<2	1.50	114.0

APPENDIX IIA Tissue Trace Metal Concentrations - Raw Data - Vancouver Harbour, May 1985.

Station	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
	Concentration (µg/g dry weight)													
					- HEPATOPANCREAS									
	113	38	0.62	29.40	0.7	852.0	1230.0	0.66	1920	7.65	4.8	<2	1.47	100.0
					- GILL									
	6790	45	17.50	10.00	12.2	74.5	15100	0.73	9480	149.00	46.1	13	37.00	69.7
DUNGENESS CRAB (Cancer magister) - MUSCLE														
	18	8	0.42	0.51	0.8	57.5	163.0	0.36	2250	1.79	0.8	<2	2.03	196.0
	11	24	0.19	0.26	0.7	31.2	43.6	0.30	1250	1.21	<0.4	<2	1.26	180.0
	8	23	0.09	0.27	0.8	19.9	31.3	0.18	1430	1.22	0.6	<2	1.37	181.0
	33	24	0.20	0.31	1.0	24.9	82.8	0.17	1680	2.13	0.7	<2	1.64	179.0
					- HEPATOPANCREAS									
	20	23	1.48	2.00	2.0	54.4	334.0	0.36	7410	6.77	1.5	<2	3.06	82.2
	17	13	0.73	4.40	1.3	18.3	144.0	0.16	1560	8.12	0.9	<2	1.96	125.0
	19	33	0.61	2.20	1.0	131.0	307.0	0.27	2550	8.48	3.3	5	2.03	135.0
	15	31	0.94	4.20	1.2	394.0	228.0	0.21	1690	9.27	2.2	3	1.34	93.4
					- GILL									
	364	29	2.81	1.00	1.6	101.0	876.0	0.24	4380	14.30	2.2	<2	3.51	134.0
	327	12	3.31	0.47	1.4	81.3	989.0	0.13	3050	11.20	3.4	<2	1.83	213.0
	237	15	3.55	1.29	1.6	134.0	947.0	0.19	4790	11.10	2.8	<2	6.00	222.0
	211	13	3.00	1.11	1.1	108.0	1420.0	0.10	4040	8.43	4.4	<2	8.00	152.0
STERLING (ST)														
DUNGENESS CRAB (Cancer magister) - MUSCLE														
	7	21	0.1	<0.04	<0.4	48.4	27.5	0.18	2220	1.06	<0.4	<2	0.09	165
	7	16	0.14	<0.04	0.5	28.2	31	0.23	1430	0.98	<0.4	<2	0.20	161

APPENDIX IIA Tissue Trace Metal Concentrations - Raw Data - Vancouver Harbour, May 1985.

Station	Concentration (µg/g dry weight)													
	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
					- HEPATOPANCREAS									
	9	14	0.73	1.9	0.6	512	242	0.23	2060	6.79	0.7	<2	0.20	81.3
	13	31	1.00	3.9	0.9	175	281	0.21	2230	8.34	2.2	4	0.65	97.6
					- GILL									
	96	9	1.38	0.42	0.5	124	266	0.08	4580	5.31	0.5	<2	0.49	101
	88	8	3.83	0.78	1.8	205	1480	0.10	3930	5.05	1.3	<2	1.36	156
VANTERM (VT)														
DUNGENESS CRAB (Cancer magister) - MUSCLE														
	11	31	0.2	<0.04	0.7	42.2	43.5	0.94	1450	0.95	<0.4	<2	<0.08	155
	86	33	0.7	0.16	0.7	66.1	263.0	1.61	2800	2.42	0.5	<2	0.37	296
					- HEPATOPANCREAS									
	98	51	1.02	3.9	0.9	888	613	1.06	1330	7.57	2.1	3	0.48	88.5
					- GILL									
	2630	19	12.4	0.95	7.6	321	5440	0.24	5190	55.4	2.9	9	24	162
	8910	29	53.6	3.40	27.7	317	16200	0.51	9990	170.0	<0.4	23	126	385
CHEVRON (CV)														
DUNGENESS CRAB (Cancer magister) - MUSCLE														
	<5	14	0.20	0.46	2.1	56.2	33.3	0.28	1860	1.20	<0.5	<2	2.70	122.0
					- HEPATOPANCREAS									
	<40	<40	<0.80	4.00	<4.0	410.0	122.0	0.12	3400	7.00	<4.0	<20	1.76	60.0
					- GILL									
	18	5	0.69	0.4	2.1	156.0	84.6	0.10	3850	3.93	<0.4	<2	2.91	73.3

APPENDIX IIA Tissue Trace Metal Concentrations - Raw Data - Vancouver Harbour, May 1985.

Station	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
	Concentration (µg/g dry weight)													
CATES PARK (CP)														
DUNGENESS CRAB (*Cancer magister*) - MUSCLE														
	12	15	0.70	0.34	0.6	37.1	49.2	<0.02	1750	1.4	<0.4	<2	1.66	179.0
	16	11	0.15	0.22	0.6	47.6	52.4	<0.03	1890	1.4	<0.4	<2	1.77	186.0
	22	20	0.20	0.56	0.7	71.3	56.8	1.02	2760	1.3	<0.4	<2	2.00	195.0
- HEPATOPANCREAS														
	4	25	0.73	1.10	0.8	228.0	153.0	0.11	1780	8.6	2.2	5	1.92	200.0
	8	34	1.51	1.30	1.3	595.0	303.0	0.11	3220	12.6	3.8	6	5.00	213.0
	<4	8	0.71	0.50	0.9	476.0	309.0	0.18	2590	5.4	0.9	<2	1.96	84.3
- GILL														
	70	4	1.99	0.50	0.8	241.0	376.0	0.06	5740	4.4	0.7	<2	3.60	157.0
	179	<4	2.22	0.65	0.9	226.0	546.0	0.03	5560	7.9	1.3	<2	4.00	185.0
	94	4	1.14	0.40	0.7	195.0	765.0	0.36	5420	4.6	1.3	<2	3.92	136.0
BOULDER ROCK (BR)														
DUNGENESS CRAB (*Cancer magister*) - MUSCLE														
	42.0	20.0	0.37	0.09	0.6	55.9	120.0	-	1700	2.6	<0.4	<2.0	0.27	209.0
	51.0	8.0	0.13	0.05	<0.4	46.2	73.9	-	1480	1.2	<0.4	<2.0	0.31	175.0
	38.0	10.0	0.23	0.05	0.5	44.0	77.2	-	1550	1.6	<0.4	<2.0	0.17	155.0
- HEPATOPANCREAS														
	23.0	26.0	1.18	0.80	1.6	274.0	245.0	-	3320	12.0	1.0	<2.0	3.0	104.0
	16.0	24.0	0.81	0.64	1.0	90.0	295.0	-	2250	8.4	0.5	<2.0	0.15	65.4
	15.0	19.0	0.60	4.00	1.0	191.0	275.0	-	2270	9.9	1.5	4.0	3.0	250.0
- GILL														
	56.0	12.0	2.48	3.70	0.5	63.9	168.0	-	1270	17.9	<0.4	<2.0	<2.0	873.0
	994.0	10.0	5.51	0.44	3.0	331.0	2180.0	-	4190	21.0	<0.4	3.0	14.0	184.0
	358.0	8.0	2.60	0.34	1.4	262.0	884.0	-	4560	11.4	<0.4	<2.0	6.0	226.0

APPENDIX IIA Tissue Trace Metal Concentrations - Raw Data - Vancouver Harbour, May 1985.

Station	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
						Concentration (µg/g dry weight)								
PORT MOODY (PM)														
DUNGENESS CRAB (Cancer magister) - MUSCLE														
	16	5	0.14	0.18	0.6	38.6	33.7	0.20	1380	0.95	<0.4	<2	0.97	149.0
	9	<4	0.18	0.20	0.6	37.3	36.5	0.10	1390	0.88	0.4	<2	1.37	146.0
					- HEPATOPANCREAS									
	10	22	0.72	1.00	1.0	23.2	243.0	0.14	1510	6.17	1.6	<2	1.34	104.0
	5	14	0.95	1.30	1.1	174.0	292.0	0.13	1950	11.70	1.8	<2	1.12	103.0
					- GILL									
	339	16	2.97	0.80	1.9	180.0	1860.0	0.14	4800	8.28	0.8	<2	14.00	190.0
	344	13	3.23	0.50	1.8	287.0	1280.0	0.09	4590	9.01	1.7	<2	10.00	219.0
SOLE & FLOUNDER														
PACIFIC ENVIRONMENT INSTITUTE (PEI)														
ENGLISH SOLE (Parophrys vetulus) - MUSCLE														
	<4.0	19.0	<0.08	0.07	0.5	1.0	9.2	-	1440	0.82	<0.4	<2.0	<0.08	15.3
DOVER SOLE (Microstomus pacificus) - MUSCLE														
	4.0	121.0	<0.08	0.05	0.6	1.0	21.2	-	1380	0.93	<0.4	<2.0	<0.08	18.1
	<4.0	63.0	0.08	0.05	0.7	1.5	21.4	-	1300	1.16	<0.4	<2.0	<0.08	17.6
	<4.0	97.0	<0.08	0.65	0.5	2.2	18.2	-	1350	1.00	<0.4	<2.0	<0.08	17.8
	<4.0	87.0	0.16	0.05	0.6	2.2	26.7	-	1320	1.68	<0.4	<2.0	0.16	23.3
	20.0	52.0	0.29	0.04	0.5	2.0	53.1	-	1260	2.87	<0.4	<2.0	0.45	23.4
	16.0	59.0	0.77	0.08	0.7	2.1	42.9	-	1330	3.50	<0.4	<2.0	0.12	30.3
ROCK SOLE (Lepidopsetta bilineata) - MUSCLE														
	<4.0	79.0	<0.08	0.10	0.7	0.9	11.2	-	1420	0.78	<0.4	<2.0	<0.08	14.7

APPENDIX IIA Tissue Trace Metal Concentrations - Raw Data - Vancouver Harbour, May 1985.

Station	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
	Concentration (µg/g dry weight)													
- GILL														
	280.0	<10.0	1.10	0.20	2.0	8.0	665.0	-	1010	11.70	<1.0	<5.0	0.40	107.0
REX SOLE (Glyptocephalus zachirus) - MUSCLE														
	<4.0	53.0	<0.08	0.06	0.7	1.3	9.3	-	1290	1.02	<0.4	<2.0	<0.08	17.8
	<4.0	70.0	0.16	0.10	0.6	1.2	35.0	-	1170	1.17	<0.4	<2.0	0.16	14.7
- LIVER														
	5.0	<4.0	<0.08	1.30	0.7	1.5	160.0	-	196	1.74	<0.4	<2.0	0.08	29.5
- GILL														
	106.0	48.0	0.80	0.33	1.1	5.6	302.0	-	1070	40.70	<0.5	<2.0	0.20	164.0
BURRARD YARROWS (BY)														
ENGLISH SOLE (Parophrys vetulus) - MUSCLE														
	<4	51	0.11	<0.04	0.60	<0.4	54.1	0.21	1190	0.81	<0.4	<2	0.11	19.4
	<4	81	0.10	<0.04	0.50	<0.4	20.2	0.16	1190	0.59	<0.4	<2	0.13	28.9
- LIVER														
	11	17	1.53	2.1	0.6	15.6	297.0	0.02	661	3.65	<0.4	<2	1.09	115.0
	32	20	<0.80	2.2	0.7	28.5	268.0	0.10	731	4.51	0.7	<2	0.53	101.0
- GILL														
	65	<5	1.00	0.12	1.5	3.6	425.0	-	1630	7.0	<0.5	<2	0.20	83.7
	302	<6	1.70	0.09	1.4	4.1	770.0	-	1510	13.7	<0.6	<2	0.50	80.8
DOVER SOLE (Microstomus pacificus) - MUSCLE														
	<4	70	0.16	0.06	0.7	<0.4	18.1	0.26	1150	1.04	<0.4	<2	<0.08	24.6
	<4	80	0.13	0.06	0.8	<0.4	18.5	0.20	1190	0.64	<0.4	<2	0.30	21.8

APPENDIX IIA Tissue Trace Metal Concentrations - Raw Data - Vancouver Harbour, May 1985.

Station	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
	Concentration (µg/g dry weight)													
- LIVER														
	32	25	0.21	2.2	0.8	12.1	397.0	0.16	845	3.72	1.3	<2	0.76	89.2
	14	41	<0.08	2.0	<0.4	18.0	803.0	0.12	823	3.68	1.1	<2	0.70	104.0
- GILL														
	50	<10	0.30	0.20	<1.0	<1.0	365.0	-	1570	5.3	2.0	<5	0.40	86.1
	33	<5	0.20	0.12	0.9	2.2	297.0	<0.03	1490	4.7	1.0	<2	0.20	82.9
ROCK SOLE (Lepidopsetta bilineata) - MUSCLE														
	<4	6	<0.08	<0.04	0.9	<0.4	18.2	0.86	1380	0.43	<0.4	<2	0.63	18.2
	<4	6	<0.08	0.09	0.7	<0.4	14.3	0.35	1430	0.71	<0.4	<2	0.09	17.8
- LIVER														
	<4	126	<0.08	0.95	0.6	14.0	558.0	0.75	855	4.57	<0.4	<2	0.29	120.0
	<4	40	<0.08	0.42	0.7	20.6	203.0	0.15	1080	6.84	<0.4	<2	0.33	125.0
- GILL														
	17	<5	0.20	0.05	<0.5	1.5	173.0	0.28	970	3.8	<0.5	<2	0.20	74.5
	15	<5	0.49	0.76	0.8	1.8	191.0	0.10	1260	6.3	<0.5	<2	0.28	93.4
SANDDAB SOLE (Citharichthys spp.) - MUSCLE														
	<4	14	0.08	<0.04	0.4	<0.4	9.7	0.37	1480	0.42	<0.4	<2	<0.08	13.1
STARRY FLOUNDER (Platichthys stellatus) - MUSCLE														
	<4	6	0.08	0.07	0.5	<0.4	34.1	0.54	1250	0.78	<0.4	<2	<0.08	28.7
- LIVER														
	28	<4	0.19	4.5	0.5	81.7	1140.0	0.66	896	4.53	<0.4	<2	0.79	183.0
- GILL														
	28	<4	1.38	0.16	0.8	2	162.0	0.08	1130	13.6	<0.4	<2	0.15	95.0

APPENDIX IIA Tissue Trace Metal Concentrations - Raw Data - Vancouver Harbour, May 1985.

Station	Concentration (µg/g dry weight)													
	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
COAL HARBOUR (CH)														
ENGLISH SOLE (Parophrys vetulus) - MUSCLE														
	5	89	0.12	0.23	0.7	0.7	23.2	0.12	1190	7.20	<0.4	<2	1.12	21.7
	8	21	0.09	0.21	0.7	0.8	25.5	0.52	1190	0.73	<0.4	<2	0.97	19.1
	<4	98	<0.08	0.25	0.6	1.3	18.9	0.34	1120	0.55	<0.4	<2	1.24	22.1
	<4	49	0.23	0.23	0.5	0.7	13.1	0.15	867	1.00	<0.4	<2	1.07	17.1
	<4	78	0.17	0.22	1.0	1.4	15.6	0.13	1100	1.27	<0.4	<2	1.22	31.5
- LIVER														
	14	37	<0.10	2.50	1.0	4.8	660.0	0.11	690	5.00	2.4	2	1.70	103.0
	102	39	0.46	1.50	1.2	8.7	752.0	0.09	847	5.81	2.8	<2	5.00	108.0
	18	22	<0.08	2.30	0.5	4.9	919.0	0.07	523	3.89	2.4	<2	0.87	91.6
- GILL														
	65	<5	0.72	0.19	1.8	2.6	381.0	<0.06	1510	25.20	1.3	<2	3.00	75.6
	81	<8	0.40	<0.3	0.8	4.0	502.0	0.08	1650	5.10	2.0	<3	<3.00	65.8
	114	<5	1.02	0.40	1.3	7.8	493.0	<0.03	1600	13.50	<0.5	<2	3.00	96.6
DOVER SOLE (Microstomus pacificus) - MUSCLE														
	6	29	0.21	0.23	0.8	0.8	104.0	0.21	1090	1.63	0.5	<2	1.21	20.0
	<4	65	<0.08	0.31	0.5	0.7	18.7	0.24	1080	0.30	<0.4	<2	1.47	15.8
	<4	65	0.10	0.29	0.7	1.2	24.0	0.34	1050	0.54	<0.4	<2	1.37	21.0
	<4	84	<0.08	0.24	0.6	1.3	16.7	0.17	1080	0.69	<0.4	<2	1.21	26.0
- LIVER														
	17	25	<0.08	1.90	1.0	18.6	937.0	0.18	555	3.99	2.4	<2	6.00	123.0
- GILL														
	70	<5	0.30	0.23	1.3	4.7	493.0	0.05	1210	5.60	1.4	<2	1.60	77.2

APPENDIX IIA Tissue Trace Metal Concentrations - Raw Data - Vancouver Harbour, May 1985.

	Concentration (µg/g dry weight)													
Station	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
ROCK SOLE (Lepidopsetta bilineata) - MUSCLE														
	<4	106	<0.08	0.14	1.1	1.7	14.8	1.24	1190	0.98	<0.4	<2	0.98	31.4
- LIVER														
	7	166	<0.08	5.60	1.0	139.0	897.0	0.53	825	8.03	1.2	<2	1.57	294.0
STARRY FLOUNDER (Platichthys stellatus) - MUSCLE														
	<4	24	0.18	0.28	1.0	2.1	25.2	0.43	1220	0.86	<0.4	<2	1.29	64.7
	56	<4	1.73	0.23	1.3	1.3	126.0	1.49	1440	6.49	0.4	<2	1.13	31.1
- LIVER														
	9.	39	0.10	25.70	1.1	59.6	2180.0	-	900	5.40	6	<2	1.30	255.0
	32	18	0.40	7.10	1.1	27.3	4590.0	1.77	850	4.60	13.6	<2	1.30	172.0
- GILL														
	81	<6	0.80	0.46	1.4	3.4	388.0	-	1240	9.80	1.3	<2	1.20	138.0
	286	<5	2.70	0.50	2.0	6.5	689.0	0.80	1330	16.20	2.0	<2	3.00	98.8
STERLING (ST)														
ENGLISH SOLE (Parophrys vetulus) - MUSCLE														
	12	70	0.09	<0.04	0.6	1.6	50.5	0.51	1110	0.64	<0.4	<2	<0.08	20.3
	<4	64	0.11	<0.04	0.6	1.3	15.4	0.35	1240	0.44	<0.4	<2	0.08	21.9
	45	64	0.22	<0.04	1.4	2.5	45.8	0.23	1320	0.81	<0.4	<2	0.09	32.6
	6	64	0.09	1.91	0.8	3.0	25.7	0.28	1230	0.70	<0.4	<2	0.21	38.9
- LIVER														
	109	62	0.6	2.7	0.7	6.2	267	0.29	1010	5.85	0.9	<2	0.39	90.5
	14	21	<0.10	1.9	1.0	35.1	237	0.18	920	5.5	1.4	<2	1.3	131
ROCK SOLE (Lepidopsetta bilineata) - MUSCLE														
	<4	46	<0.08	<0.04	0.8	1.0	8.1	0.43	1180	0.62	<0.4	<2	0.28	30.3
	<4	6	<0.08	<0.04	0.5	0.9	14	0.56	1290	0.54	<0.4	<2	<0.08	17.8

APPENDIX IIA **Tissue Trace Metal Concentrations – Raw Data – Vancouver Harbour, May 1985.**

Station	Concentration (μg/g dry weight)													
	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
					– LIVER									
	16	16	<0.08	2.7	0.7	24.2	1470	–	718	2.9	0.6	<2	1.05	138
	<4	45	<0.08	0.41	1.1	15.1	192	0.28	1250	6.1	<0.4	<2	0.24	102
					– GILL									
	<6	<6	0.1	0.09	<0.6	3.5	329	0.16	860	3.9	<0.6	<2	0.3	70.4
PETRALE SOLE (Eopsetta jordani) – MUSCLE														
	4	26	0.17	<0.04	0.5	1.2	13.3	0.49	1340	1.24	<0.4	<2	0.09	20.6
	<4	25	0.1	<0.04	0.6	2.8	15	0.70	1370	0.75	<0.4	<2	0.13	20.6
					– LIVER									
	6	60	<0.08	<0.04	0.6	2.3	24.3	0.31	1230	0.58	0.4	<2	0.21	37.5
VANTERM (VT)														
ENGLISH SOLE (Parophrys vetulus) – MUSCLE														
	19	101	0.15	<0.04	0.8	<0.4	53.4	0.28	1270	0.83	<0.4	5	<0.09	17.2
	30	67	0.16	0.11	0.9	<0.4	64.7	0.21	1260	1.35	<0.4	<2	<0.08	21.8
					– LIVER									
	55	8	0.25	1.20	0.9	19.3	1070	0.34	856	4.53	0.8	<2	5.00	117
					– GILL									
	891	<5	4.3	0.09	2.9	24.6	1640	–	1880	20.1	0.5	2	4.00	74.6
DOVER SOLE (Microstomus pacificus) – MUSCLE														
	49	46	0.26	<0.04	0.8	<0.4	87.5	0.11	1460	1.91	<0.4	<2	<0.08	20.4
STARRY FLOUNDER (Platichthys stellatus) – MUSCLE														
	31	5	0.18	<0.04	0.7	4	69.1	1.02	1260	1.45	<0.4	<2	0.16	47.2

APPENDIX IIA   Tissue Trace Metal Concentrations - Raw Data - Vancouver Harbour, May 1985.

Station	Concentration (µg/g dry weight)													
	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
- LIVER														
	36	<6	0.20	6.20	1.7	140	1830	5.20	870	5.40	0.9	17	0.40	258
CHEVRON (CV)														
ENGLISH SOLE (Parophrys vetulus) - MUSCLE														
	11	17	0.10	0.18	2.1	1.6	20.0	0.65	1060	1.39	<0.4	<2	1.00	5.2
	<4	41	0.20	0.14	3.1	2.2	28.8	0.06	970	0.88	<0.4	<2	1.15	2.5
	<4	16	0.37	0.24	1.0	1.3	18.8	0.48	1260	4.95	<0.4	<2	1.53	7.7
- LIVER														
	7	34	<0.08	4.90	1.2	24.5	194.0	0.66	659	5.06	0.8	<2	1.63	90.6
	120	31	<0.10	3.60	1.5	11.3	2560.0	0.14	720	3.80	2.3	<3	1.60	95.2
	25	69	<0.10	6.80	1.1	10.9	1050.0	0.44	780	6.30	0.7	<3	1.30	72.3
- GILL														
	34	<7	0.30	0.20	4.7	4.9	189.0	0.22	1170	7.50	<0.7	<3	1.30	47.8
	43	<7	0.20	0.22	1.6	2.6	540.0	<0.03	960	4.90	<0.7	<3	1.70	51.8
	<8	<8	<0.20	0.16	3.0	2.3	134.0	0.14	900	7.20	<0.8	<3	1.00	40.0
REX SOLE (Glyptocephalus zachirus) - MUSCLE														
	<4	18	0.13	0.18	2.2	3.3	26.3	0.67	1320	0.88	<0.4	<2	1.59	<0.2
	<4	6	0.08	0.16	1.3	1.9	15.5	0.41	1420	1.69	<0.4	<2	1.31	<0.2
	<4	11	0.19	0.16	1.3	0.8	15.6	0.75	1370	3.84	<0.4	<2	1.37	<0.2
- LIVER														
	<7	47	<0.10	1.00	2.9	7.3	339.0	0.07	650	6.60	0.8	<3	1.00	33.3
	<7	17	<0.10	0.70	2.4	4.6	109.0	0.19	440	4.90	0.7	<3	0.70	8.0
	<8	47	<0.20	0.90	3.2	9.7	547.0	0.31	570	13.60	<0.8	<3	1.10	40.0

APPENDIX IIA Tissue Trace Metal Concentrations - Raw Data - Vancouver Harbour, May 1985.

Station	Concentration (μg/g dry weight)												
	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
- GILL														
	19	<7	2.20	0.16	4.9	2.4	82.8	0.09	1380	25.70	<0.7	<3	0.80	26.1
	13	<4	2.93	0.12	2.7	4.5	97.1	0.27	1320	32.70	<0.4	<2	0.86	50.8
	9	<7	1.30	0.42	6.1	2.4	124.0	0.23	990	28.80	<0.7	<3	0.70	45.6
ROUGHSCALE SOLE (Clidoderma asperrimum) - MUSCLE														
	<5	26	<0.10	0.12	0.9	0.5	10.9	0.68	960	0.50	<0.5	<2	0.90	12.2
	<4	33	0.12	0.14	0.6	0.9	13.3	0.24	1120	1.59	0.5	<2	1.07	15.2
	<4	33	0.08	0.18	0.7	0.9	12.9	0.19	1080	0.80	<0.4	<2	1.19	16.5
- LIVER														
	<4	138	<0.08	6.60	0.8	13.4	522.0	0.78	690	5.38	1.1	<2	1.53	110.0
	11	84	<0.10	2.90	0.8	38.9	1600.0	0.36	640	3.90	3.3	<3	1.70	124.0
	<7	51	<0.10	2.70	1.3	15.5	1520.0	0.30	590	3.20	1.5	<3	1.20	132.0
- GILL														
	<7	8	0.10	0.20	5.4	3.2	189.0	0.31	1450	6.80	<0.7	<3	1.00	92.2
	<7	8	0.10	0.20	1.5	3.7	124.0	0.09	920	5.90	<0.7	<3	1.30	82.5
	<8	<8	<0.20	0.20	2.0	3.2	169.0	0.07	1060	3.10	<0.8	<3	1.20	81.2
CATES PARK (CP)														
ENGLISH SOLE (Parophrys vetulus) - MUSCLE														
	<4	50	0.24	0.22	0.7	1.1	21	0.20	1230	1.1	<0.4	<2	1.67	26.7
	<4	74	0.17	0.18	0.6	0.8	17	0.08	1210	0.9	<0.4	<2	1.43	21.2
	8	25	0.31	0.22	0.7	1.3	23	0.42	1470	1.8	<0.4	<2	1.67	24.2
- LIVER														
	31	69	<0.08	2.80	0.6	9.5	1410	0.23	710	3.1	1.8	<2	1.40	89.0
	25	40	0.11	1.90	0.7	27.2	474	<0.02	689	3.8	1.0	<2	1.63	120.0
	16	84	<0.08	4.30	0.7	24.9	2340	0.05	865	4.2	3.1	<2	2.23	155.0

APPENDIX IIA Tissue Trace Metal Concentrations – Raw Data – Vancouver Harbour, May 1985.

	Concentration (µg/g dry weight)												
Station	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
– GILL														
	30	<7	0.30	0.14	1.3	2.7	292	–	1000	4.5	<0.7	<3	1.30	73.0
	9	<7	0.70	0.14	1.5	2.9	218	0.03	1120	5.0	<0.7	<3	0.70	76.4
	<8	<8	<0.20	0.14	<0.8	3.6	273	0.09	1450	4.0	1.1	<3	0.80	68.4
ROCK SOLE (Lepidopsetta bilineata) – MUSCLE														
	<4	70	0.11	0.75	0.6	0.9	13	0.25	1360	0.7	0.5	<2	1.27	20.3
	<4	26	0.22	0.20	0.7	0.8	61	0.19	1300	1.2	<0.4	<2	1.74	21.7
	<4	47	<0.08	0.16	0.6	0.6	10	0.19	1370	0.7	<0.4	<2	1.65	17.0
– LIVER														
	4	77	<0.08	1.00	0.4	23.5	1790	0.30	474	2.1	1.4	<2	1.18	134.0
	<7	14	<0.10	1.50	0.8	13.6	2450	0.25	690	3.4	2.5	<3	1.10	122.0
	<7	11	0.10	1.20	<0.7	27.5	1720	0.19	680	3.0	2.8	<3	1.40	127.0
– GILL														
	<7	<7	0.10	0.22	0.9	3.3	279	0.08	1360	4.3	<0.7	<3	1.60	101.0
	11	<7	0.20	0.22	1.1	3.8	232	–	1060	4.9	<0.7	<3	1.40	99.0
	10	<7	0.20	0.32	1.3	2.9	187	–	2860	5.0	0.9	<3	1.60	87.1
FLATHEAD SOLE (Hippoglossoides ellasodon) – MUSCLE														
	<4	27	<0.08	0.14	0.6	1.0	15	0.57	1360	0.6	<0.4	<2	1.16	16.6
– LIVER														
	<8	57	<0.2	2.70	0.9	76.0	1070	0.13	970	4.9	1.2	<3	1.40	172.0
– GILL														
	18	<7	0.10	0.22	1.4	2.5	123	0.08	1490	5.1	0.9	<3	1.20	80.6

APPENDIX IIA Tissue Trace Metal Concentrations - Raw Data - Vancouver Harbour, May 1985.

Station	Concentration (μg/g dry weight)												
	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
BOULDER ROCK (BR)														
ENGLISH SOLE (Parophrys vetulus) - MUSCLE														
	93.0	19.0	0.84	<0.04	0.9	2.7	148.0	-	1520	4.7	<0.4	<2.0	0.16	32.0
	7.0	65.0	0.14	<0.04	0.4	1.8	30.1	-	1160	0.7	<0.4	<2.0	0.13	42.6
	24.0	40.0	0.19	<0.04	0.5	1.5	53.4	-	1300	1.2	<0.4	<2.0	0.41	22.2
- LIVER														
	57.0	25.0	0.12	3.8	0.5	14.7	1180.0	-	741	4.1	<0.4	<2.0	0.66	107.0
	21.0	34.0	<.08	2.8	0.6	12.7	204.0	-	788	3.9	<0.4	<2.0	5.00	110.0
	11.0	10.0	<.08	1.2	0.4	16.4	191.0	-	598	3.3	<0.4	<2.0	0.67	92.5
- GILL														
	274.0	<5.0	1.30	0.52	1.4	6.6	655.0	-	1510	9.7	<0.5	<2.0	0.40	73.8
	106.0	5.0	0.53	0.08	0.8	5.9	430.0	-	1490	5.7	<0.4	<2.0	0.42	69.6
	113.0	<4.0	1.34	0.05	1.1	3.0	362.0	-	1310	7.0	<0.4	<2.0	0.45	76.7
ROCK SOLE (Lepidopsetta bilineata) - MUSCLE														
	15.0	39.0	0.11	<.04	0.4	1.4	35.8	-	1290	0.9	<0.4	<2.0	0.11	20.1
	25.0	77.0	0.14	<.04	0.6	1.2	46.7	-	1380	1.1	<0.4	<2.0	0.15	23.4
	26.0	118.0	0.18	0.04	0.5	2.4	58.2	-	1310	1.0	<0.4	<2.0	0.16	27.1
- LIVER														
	20.0	32.0	0.20	1.4	0.6	11.8	452.0	-	690	3.8	<0.5	<2.0	4.0	94.5
	9.0	42.0	0.10	1.15	<0.5	8.4	360.0	-	670	3.3	<0.5	<2.0	3.0	105.0
	25.0	167.0	<0.08	1.6	0.5	33.3	1790.0	-	698	3.2	<0.4	<2.0	2.0	116.0
- GILL														
	47.0	6.0	1.10	0.10	1.1	7.0	157.0	-	1270	5.4	<0.5	<2.0	6.0	67.3
	124.0	4.0	1.90	0.08	1.4	3.3	248.0	-	1710	8.0	<0.4	<2.0	7.0	87.1
	209.0	12.0	3.42	0.06	1.6	4.2	405.0	-	1620	9.8	<0.4	<2.0	8.0	91.1

APPENDIX IIA Tissue Trace Metal Concentrations - Raw Data - Vancouver Harbour, May 1985.

	Concentration (µg/g dry weight)													
Station	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
C-O SOLE (Pleuronichthys coenosus) - MUSCLE														
	12.0	14.0	0.12	<0.04	0.4	1.6	32.0	-	1250	0.62	<0.4	<2.0	0.08	16.5
	<4.0	15.0	0.12	<0.04	<0.4	1.6	18.2	-	1160	0.45	<0.4	<2.0	0.15	15.6
- LIVER														
	41.0	17.0	<.08	5.5	<0.4	53.0	1720.0	-	685	3.42	<0.4	<2.0	4.0	163.0
PORT MOODY (PM)														
ENGLISH SOLE (Parophrys vetulus) - MUSCLE														
	<4	232	<0.08	0.24	0.6	1.5	22.4	0.22	1400	0.58	<0.4	<2	1.55	23.8
	14	55	0.10	0.22	0.7	1.2	33.0	0.24	1570	0.80	<0.5	<2	1.58	27.2
	<4	81	<0.08	0.12	<0.4	0.8	21.8	0.29	932	0.40	<0.4	<2	0.84	15.3
- LIVER														
	5	106	<0.08	0.70	<0.4	5.9	771.0	-	270	1.42	1.0	<2	0.96	40.5
	27	15	<0.08	1.90	0.7	10.7	459.0	0.19	740	3.50	0.8	<2	2.13	110.0
	10	23	<0.08	1.10	0.7	8.4	177.0	0.21	810	4.37	0.6	<2	3.64	128.0
- GILL														
	100	<10	0.60	0.20	1.0	5.0	540.0	0.05	1290	5.90	<1.0	<5	0.70	77.5
	144	<4	2.19	0.13	2.6	3.7	531.0	0.07	1540	12.40	<0.4	<2	1.38	74.9
	90	<10	0.70	0.20	1.0	4.0	412.0	<0.02	1520	6.60	<1.0	<4	0.90	76.5
STARRY FLOUNDER (Platichthys stellatus) - MUSCLE														
	<4	18	0.12	0.17	0.5	1.1	21.9	0.24	1000	0.58	<0.4	<2	1.07	17.1
	9	15	0.13	0.20	0.7	1.5	40.5	0.20	1310	0.95	<0.4	<2	1.43	24.8
- LIVER														
	28	6	0.12	3.00	0.9	106.0	1790.0	0.37	790	5.15	1.9	<2	3.22	223.0
	13	5	<0.08	1.30	0.8	50.2	1470.0	0.13	796	3.44	1.7	<2	1.67	155.0

APPENDIX IIA Tissue Trace Metal Concentrations - Raw Data - Vancouver Harbour, May 1985.

	Concentration (µg/g dry weight)													
Station	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
- GILL														
	95	<4	0.40	0.28	1.1	6.6	417.0	0.05	1150	13.20	0.5	<2	2.09	93.3
	41	<4	0.25	0.23	0.8	3.4	405.0	0.05	1010	5.42	<0.4	<2	3.68	76.0
OTHER FISH - SPECIES														
PACIFIC ENVIRONMENT INSTITUTE (PEI)														
BLACK COD (Anoplopoma fimbria) - MUSCLE														
	<4.0	<4.0	0.31	<0.04	0.4	1.6	28.3	-	1490	1.33	<0.4	<2.0	<0.08	18.6
- LIVER														
	<4.0	6.0	<0.08	7.60	0.5	15.3	1040.0	-	708	4.38	<0.4	<2.0	<0.08	109.0
- GILL														
	110.0	<5.0	5.30	0.49	1.3	5.8	459.0	-	1640	17.20	<0.5	<2.0	<0.10	83.1
POLLOCK (Theragra chalcogramma) - MUSCLE														
	<4.0	12.0	<0.08	0.14	0.4	2.5	12.6	-	1660	0.78	<0.4	<2.0	<0.08	18.5
- LIVER														
	<4.0	6.0	<0.08	<0.04	<0.4	8.6	147.0	-	180	6.35	<0.4	<2.0	0.10	45.2
- GILL														
	34.0	5.0	1.20	0.78	1.0	28.3	396.0	-	1330	15.80	<0.5	2.0	0.30	88.4
DOGFISH (Squalus acathias) - MUSCLE														
	6.0	23.0	<0.08	<0.04	<0.4	2.2	24.1	-	508	0.50	<0.4	<2.0	0.11	7.4
	<4.0	8.0	<0.08	<0.04	<0.4	2.5	21.0	-	390	0.34	<0.4	<2.0	<0.08	7.2
- LIVER														
	4.0	10.0	<0.05	0.31	<0.3	2.8	37.2	-	45	0.38	<0.3	<1.0	<0.05	6.9
	<2.0	4.0	<0.05	0.75	<0.2	1.1	58.7	-	37	0.38	<0.2	<1.0	<0.05	6.2

APPENDIX IIA Tissue Trace Metal Concentrations - Raw Data - Vancouver Harbour, May 1985.

Station	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
					Concentration (µg/g dry weight)									
RATFISH (Hydrolagus colliei) - MUSCLE														
	10.0	68.0	<0.08	1.18	<0.4	1.5	38.2	-	1100	1.15	<0.4	<2.0	<0.08	14.0
	12.0	34.0	0.10	0.18	1.4	4.0	37.7	-	947	1.10	<0.4	<2.0	0.14	13.8
	<4.0	67.0	<0.08	0.22	<0.4	1.0	18.7	-	1160	0.81	<0.4	<2.0	<0.08	15.2
	7.0	60.0	<0.08	0.23	<0.4	1.1	29.1	-	1070	0.99	<0.4	<2.0	0.08	14.7
	<4.0	88.0	<0.08	0.38	0.6	1.0	13.8	-	1120	0.97	<0.4	<2.0	<0.08	14.4
- LIVER														
	<3.0	10.0	<0.05	0.56	<0.3	2.8	104.0	-	35	0.38	<0.3	<1.0	<0.05	4.6
	<3.0	8.0	<0.05	0.24	<0.3	3.0	156.0	-	33	0.37	<0.3	<1.0	0.11	5.0
	<2.0	7.0	<0.05	0.14	<0.2	2.4	80.9	-	29	0.28	<0.2	<1.0	<0.05	3.7
	<2.0	9.0	<0.05	0.52	<0.2	2.3	141.0	-	24	0.27	<0.2	<1.0	<0.05	3.7
	<3.0	10.0	<0.06	0.24	<0.3	.2.2	88.6	-	24	0.32	<0.3	<1.0	0.07	4.0
- GILL														
	126.0	14.0	0.48	0.06	0.7	7.7	353.0	-	787	9.93	<0.4	3.0	0.17	51.7
	52.0	15.0	0.26	0.05	0.4	5.5	254.0	-	779	4.89	<0.4	<2.0	0.12	46.2
	188.0	14.0	1.17	0.15	0.9	8.0	449.0	-	986	20.30	<0.4	4.0	0.18	57.4
	38.0	20.0	0.18	0.06	<0.4	4.2	163.0	-	668	3.68	<0.4	<2.0	0.09	35.2
	90.0	18.0	0.46	<0.04	0.8	6.5	317.0	-	903	19.60	<0.4	<2.0	<0.08	50.6
LONGNOSE SKATE (Raja rhina) - MUSCLE														
	<4.0	87.0	<0.08	0.07	0.6	1.9	17.3	-	1010	0.77	<0.4	<2.0	<0.08	12.1
	8.0	86.0	0.14	0.45	0.5	1.3	20.9	-	1210	0.98	<0.4	<2.0	0.09	14.1
	<4.0	57.0	0.12	0.05	<0.4	1.3	34.4	-	1190	1.32	<0.4	<2.0	<0.08	15.1
- LIVER														
	<2.0	7.0	<0.05	0.20	<0.2	5.6	43.0	-	39	0.44	<0.2	<1.0	0.06	6.9
	<4.0	15.0	<0.08	0.60	<0.4	15.2	106.0	-	214	1.99	0.4	<2.0	<0.08	26.9
	<4.0	14.0	<0.08	0.05	<0.4	13.4	149.0	-	177	1.86	<0.4	<2.0	<0.08	24.8
	<2.0	8.0	<0.05	0.29	<0.2	8.2	39.6	-	38	0.62	<0.2	<1.0	<0.05	9.0

APPENDIX IIA Tissue Trace Metal Concentrations - Raw Data - Vancouver Harbour, May 1985.

	Concentration (µg/g dry weight)													
Station	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
COAL HARBOUR (CH)														
TOMCOD (Microgadus proximus) - MUSCLE														
	6	5	0.13	0.23	0.9	2.6	31.5	0.32	1380	1.18	<0.4	<2	1.03	33.9
	<4	5	<0.08	<0.20	0.5	0.5	20.1	0.63	1520	0.69	<0.4	<2	1.08	20.9
WALLEYE POLLOCK (Theragra chalcogramma) - MUSCLE														
	15	21	0.15	0.21	0.7	0.9	45.5	0.36	1380	1.97	<0.4	<2	1.08	16.7
	8	24	0.13	0.23	1.2	1.1	33.7	0.61	1420	2.47	<0.4	<2	1.16	20.0
	<4	24	0.21	0.22	0.9	0.8	23.8	0.65	1420	1.85	<0.4	<2	1.09	20.8
DOGFISH (Squalus acathias) - MUSCLE														
	<4	84	0.10	0.26	0.9	1.8	9.1	2.59	636	0.62	<0.4	<2	0.62	14.7
- LIVER														
	<4	41	<0.09	1.80	0.5	10.6	134.0	0.31	157	2.80	<0.4	<2	0.12	24.9
- GILL														
	15	34	0.31	0.34	1.1	4.0	126.0	0.71	1010	4.25	<0.4	<2	1.16	82.9
STERLING (ST)														
PACIFIC COD (Gadus macrocephalus) - MUSCLE														
	<4	5	0.1	<0.04	0.5	1.3	18.8	0.70	1520	0.97	<0.4	<2	<2.00	23.7
	8	6	0.23	<0.04	0.7	2.4	33.1	0.49	1470	1.89	<0.4	<2	<0.08	22.2
TOMCOD (Microgadus proximus) - MUSCLE														
	<4	6	<0.08	<0.04	0.6	1.8	15.7	0.33	1540	0.67	<0.4	<2	0.09	28.3
	5	11	<0.08	<0.04	0.5	1.8	19.4	0.80	1520	0.58	<0.4	<2	<0.08	28.3
DOGFISH (Squalus acathias) - MUSCLE														
	<4	19	0.1	<0.04	0.4	2.4	18.2	2.88	553	0.4	<0.4	<2	0.15	10.1

APPENDIX IIA Tissue Trace Metal Concentrations - Raw Data - Vancouver Harbour, May 1985.

	Concentration (µg/g dry weight)													
Station	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
- LIVER														
	20	25	<0.08	3.7	<0.4	8.3	215	2.16	202	2.29	0.7	<2	0.2	32.9
- GILL														
	18	8	1.57	0.13	0.9	3.5	178	1.4	1140	5.42	<0.4	<2	<0.08	57.9
VANTERM (VT)														
DOGFISH (Squalus acathias) - MUSCLE														
	6	13	0.16	<0.04	0.4	<0.4	19.9	3.09	627	0.46	<0.4	<2	<0.08	8.2
	<4	19	<0.08	<0.04	0.4	2.90	15.0	3.42	511	0.37	<0.4	<2	0.12	7.7
- LIVER														
	<4	24	<0.08	3.5	<0.4	10.3	330	0.49	202	2.13	0.8	<2	<0.08	32.2
	25	35	0.09	2.6	<0.4	13.6	345	5.16	204	1.69	0.8	<2	0.16	29.5
- GILL														
	495	8	2.13	0.36	1.9	10.3	846	1.45	1460	11.5	0.5	<2	0.45	60.1
	771	13	3.01	0.23	3.0	16.3	1460	1.86	1520	17.1	0.6	4	0.86	66.5
CATES PARK (CP)														
TOMCOD (Microgadus proximus) - MUSCLE														
	<3	6	<0.07	0.18	0.5	1.0	21	0.15	1610	0.8	<0.3	<1	1.50	25.8
	<4	6	<0.08	0.16	0.4	0.9	19	0.23	1670	1.1	<0.4	<2	1.59	26.8
- LIVER														
	<8	24	<0.2	0.80	0.9	70.3	750	-	790	3.8	0.8	<3	2.90	149.0
	<7	17	<0.1	1.00	<0.7	80.6	925	-	860	4.8	1.9	<3	2.10	161.0
- GILL														
	24	<4	0.82	0.12	0.8	3.0	136	0.05	1250	5.6	<0.4	<2	0.88	94.2
	95	<7	2.20	0.26	1.8	6.6	251	0.05	1910	11.9	<0.7	<3	1.10	102.0

APPENDIX IIA Tissue Trace Metal Concentrations - Raw Data - Vancouver Harbour, May 1985.

Station	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
	Concentration (µg/g dry weight)													
PACIFIC COD (Gadus macroephalus) - MUSCLE														
	<4	4	<0.08	0.18	<0.4	1.2	18	0.30	1500	1.3	<0.4	<2	1.38	17.1
	6	5	0.09	0.18	0.4	1.3	38	0.54	1510	1.1	<0.4	<2	1.67	17.9
- LIVER														
	<4	11	<0.08	0.44	<0.4	6.7	133	0.12	358	7.8	0.7	<2	0.99	66.5
	<4	19	<0.08	0.80	0.5	6.6	203	0.03	579	6.2	0.9	<2	1.41	79.3
- GILL														
	12	<4	2.08	0.10	1.3	2.1	109	0.11	1720	32.1	<0.4	<2	0.73	80.6
	15	<4	1.71	0.12	1.4	2.4	108	0.07	1510	23.2	<0.4	<2	0.59	72.6
WALLEYE POLLOCK (Theragra chalcogramma) - MUSCLE														
	<4	10	0.10	0.18	0.5	2.0	28	0.57	1370	1.0	<0.4	<2	1.25	23.5
- LIVER														
	<4	11	<0.08	0.80	<0.4	62.9	193	0.08	345	5.9	0.5	<2	0.37	78.9
- GILL														
	46	<4	1.77	0.26	1.2	6.4	245	<0.03	1730	18.3	<0.4	<2	0.62	82.9
BOULDER ROCK (BR)														
PACIFIC COD (Gadus macrocephalus) - MUSCLE														
	49.0	7.0	0.45	0.09	0.8	3.4	102	-	1440	2.8	<0.4	<2.0	0.22	36.7
- LIVER														
	57.0	25.0	0.37	1.4	0.8	9.2	628	-	774	8.3	<0.4	3.0	4.0	93.2
- GILL														
	81.0	6.0	1.83	0.12	1.9	2.8	186	-	1430	18.3	<0.4	2.0	3.0	70.7

APPENDIX IIA Tissue Trace Metal Concentrations - Raw Data - Vancouver Harbour, May 1985.

Station	Concentration (μg/g dry weight)													
	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
PORT MOODY (PM)														
WALLEYE POLLOCK (Theragra chalcogramma) - MUSCLE														
	<4	15	<0.08	0.15	0.5	1.8	30.2	0.46	1280	0.60	<0.4	<2	1.07	21.8
	<4	18	0.10	0.21	0.5	1.7	29.3	0.67	1430	0.89	<0.4	<2	1.45	26.6
- LIVER														
	<4	6	<0.08	0.12	<0.4	34.6	69.9	0.04	191	2.04	<0.4	<2	<0.08	42.8
	<4	6	<0.08	0.40	0.5	16.4	124.0	0.07	324	4.46	<0.4	<2	0.36	58.1
- GILL														
	180	<10	1.10	0.20	1.0	8.0	599.0	0.08	1360	10.50	<1.0	<5	0.70	92.6
	126	<4	4.51	0.08	2.0	3.7	225.0	0.04	2320	21.30	<0.4	<2	0.69	142.0
PACIFIC COD (Gadus macrocephalus) - MUSCLE														
	<4	<4	0.18	0.10	0.4	0.8	26.1	0.6	1070	1.49	<0.4	<2	0.58	17.4
	5	<4	<0.08	0.19	0.4	1.0	18.9	0.13	1490	0.82	<0.4	<2	1.26	21.5
- LIVER														
	<4	4	<0.08	0.26	<0.4	3.2	139.0	0.09	343	3.64	<0.4	<2	0.28	45.8
	<4	<4	0.12	0.06	<0.4	2.1	67.7	<0.02	247	2.85	0.4	<2	0.24	32.2
- GILL														
	30	<10	5.10	<0.1	2.0	2.0	134.0	<0.03	1740	35.40	<1.0	<5	<0.20	79.4
DOGFISH (Squalus acathias) - MUSCLE														
	<4	18	<0.08	0.07	<0.4	1.2	18.2	4.02	526	0.38	<0.4	<2	0.48	10.4

APPENDIX IIA Tissue Trace Metal Concentrations - Raw Data - Vancouver Harbour, May 1985.

Station	Concentration (µg/g dry weight)													
	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
				- LIVER										
	8	21	<0.08	0.60	<0.4	11.8	169.0	1.21	164	2.06	<0.4	<2	0.10	19.7
				- GILL										
	19	13	1.25	0.23	0.7	5.2	182.0	0.63	1070	4.50	<0.4	<2	1.37	73.7

APPENDIX IIB Tissue Trace Metal Concentrations - Raw Data - Vancouver Harbour, October 1985

Station	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	Ti	V	Zn
	Concentration (µg/g, dry weight)																		
SHRIMP																			
PACIFIC ENVIRONMENT INSTITUTE (PEI)																			
SIDESTRIPE SHRIMP (*Pandalopsis dispar*) - MUSCLE																			
	9	43	0.11	0.14	<0.4	0.6	20.2	49.4	0.19	1430	1.10	<0.4	<2	0.10	<0.8	11.2	7.2	<0.4	48.3
	14	34	0.12	0.11	<0.4	0.6	26.7	32.3	0.19	1230	1.18	<0.4	<2	0.10	<0.8	8.5	6.8	<0.4	48.7
	8	57	1.63	0.16	<0.4	0.6	17.2	26.9	0.21	1290	0.99	<0.4	<2	<0.08	<0.8	8.9	7.3	<0.4	48.6
	18	38	0.27	0.08	<0.4	0.6	18.7	37.3	0.15	1530	1.23	0.6	<2	0.23	<0.8	20.6	7.6	<0.4	49.1
	0	43	0.12	0.08	<0.4	0.6	20.8	20.0	0.14	1360	1.00	0.7	<2	<0.08	<0.8	12.3	7.2	<0.4	50.3
	19	59	0.65	0.14	<0.4	0.7	20.7	52.5	0.22	1460	1.23	0.8	<2	0.18	<0.8	14.6	7.3	<0.4	51.2
	11	73	0.10	0.12	<0.4	0.6	18.8	21.2	0.34	1430	0.93	<0.4	<2	0.10	<0.8	10.9	8.2	<0.4	52.1
- HEPATOPANCREAS																			
	14	49	0.2	55.5	<0.7	<0.7	1000	152.0	0.31	430	8.6	0.7	<3	1.1	<1	10.0	6.3	<0.7	77.5
	15	38	0.3	22.5	<0.7	0.9	525	57.9	0.18	550	6.4	1.4	<3	0.8	<1	7.7	1.2	<0.7	101.0
	<7	38	<.1	11.8	<0.7	1.4	227	50.0	0.14	340	7.4	1.0	<3	0.9	<1	6.4	6.0	<0.7	97.5
	58	45	0.3	34.7	<0.5	<0.5	839	166.0	-	600	9.4	0.8	<2	<0.1	<1	11.5	12.6	<0.5	81.1
PINK SHRIMP (*Pandalus borealis*) - MUSCLE																			
	<4	37	<0.08	0.08	<0.4	0.6	19.8	14.7	0.24	1310	0.91	0.6	<2	<0.08	<0.8	8.47	6.9	<0.4	49.6
	6	38	<0.08	0.11	<0.4	0.6	22.1	21.4	0.27	1360	1.23	<0.4	<2	<0.08	<0.8	8.73	7.4	<0.4	52.3
	14	38	<0.08	0.11	<0.4	0.6	21.7	25.7	0.24	1410	1.50	<0.4	<2	0.17	<0.8	9.05	8.7	<0.4	53.4
	<4	37	<0.08	0.05	<0.4	0.7	21.1	11.2	0.20	1380	0.92	<0.4	<2	<0.08	<0.8	8.24	7.6	<0.4	53.6
	8	54	<0.08	0.07	<0.4	0.7	23.3	21.5	0.38	1440	1.19	<0.4	<2	<0.08	<0.8	8.73	8.1	<0.4	58.5
	15	36	0.2	0.05	<0.5	0.6	20.8	30.1	0.23	1400	1.30	<0.5	<2	0.50	<1.0	20.60	7.6	<0.5	52.6
- HEPATOPANCREAS																			
	24	28	0.2	5.2	<0.7	<0.7	304	170	0.19	430	6.0	2.2	<3	0.4	<1	7.5	6.7	0.7	62.5
	389	22	1.8	6.8	1.5	1.5	418	848	0.21	650	14.2	1.5	<3	0.7	<1	11.7	21.6	1.5	66.3
	30	33	0.3	8.8	0.8	0.8	351	196	0.19	400	6.6	1.4	<3	0.2	<1	7.8	7.3	0.7	55.2
	16	29	0.2	12.3	<0.7	1.0	522	168	0.22	340	5.5	1.9	<3	0.7	<1	5.2	5.9	0.8	58.8

APPENDIX IIB Tissue Trace Metal Concentrations - Raw Data - Vancouver Harbour, October 1985

	Concentration (µg/g, dry weight)																		
Station	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	Ti	V	Zn
SMOOTH PINK SHRIMP (Pandalus jordani) - MUSCLE																			
	22	22	0.15	0.11	<0.4	0.6	24.8	42.1	0.13	1390	1.5	<0.4	<2	0.08	<0.8	11.1	8.5	<0.4	52.5
	15	30	0.15	0.06	<0.4	0.6	24.8	36.9	0.17	1290	1.3	<0.4	<2	0.13	<0.8	8.6	8.2	<0.4	50.5
	9	29	<0.08	0.05	<0.4	0.6	24.8	21.4	0.19	1330	1.1	<0.4	<2	0.10	<0.8	9.7	8.2	<0.4	52.1
	22	26	0.15	0.06	<0.4	0.5	24.5	43.4	0.14	1400	1.6	<0.4	<2	0.24	<0.8	11.4	7.9	<0.4	53.0
BURRARD YARROWS (BY)																			
COONSTRIPE SHRIMP (Pandalus danae) - MUSCLE																			
	16	12	0.52	0.50	<0.4	0.6	22.6	38.5	0.50	1500	1.39	<0.4	<2	<0.08	<0.8	85.3	8.3	<0.4	51.8
	20	12	0.15	0.06	<0.4	0.6	17.6	40.5	0.52	1430	1.45	<0.4	<2	0.11	<0.8	15.8	8.9	<0.4	59.6
	8	15	0.09	0.05	<0.4	0.5	22.1	23.2	0.58	1400	1.06	0.5	<2	<0.08	<0.8	8.8	8.3	<0.4	55.1
	9	18	0.12	0.06	<0.4	0.6	17.7	21.9	0.56	1380	0.91	<0.4	<2	0.14	<0.8	9.1	8.2	<0.4	50.3
	11	14	0.18	<0.04	<0.4	0.5	14.6	23.8	0.55	1450	0.94	<0.4	<2	<0.08	<0.8	16.2	5.4	<0.4	49.1
	<4	17	<0.08	<0.04	<0.4	0.4	24.3	16.4	0.51	1360	0.93	<0.4	<2	<0.08	<0.8	7.7	7.7	<0.4	54.2
- HEPATOPANCREAS																			
	8	18	0.30	7.0	<0.7	<0.7	358	384	0.49	620	7.2	1.5	<3	0.4	<1	13.0	4.0	0.7	74.0
	9	12	0.20	4.2	2.6	<0.7	435	463	0.12	540	5.7	2.4	<3	0.4	<1	11.5	3.9	2.1	71.8
	30	22	0.34	3.3	1.7	0.7	269	297	0.12	729	6.3	1.6	<2	0.2	<0.8	14.5	8.0	1.3	75.7
	23	13	0.30	4.7	2.3	<0.7	361	508	0.11	480	5.4	1.4	<3	1.1	<1	9.8	3.5	0.8	69.4
COAL HARBOUR (CH)																			
HUMPBACK SHRIMP (Pandalus hypinotus) - MUSCLE																			
	17	18	0.14	<0.04	<0.4	<0.4	17.1	40.0	0.10	1400	1.47	<0.4	<2	<0.08	<0.8	17.2	7.9	<0.4	49.1
	26	14	0.17	0.05	<0.4	0.5	20.0	52.9	0.09	1390	1.51	<0.4	<2	0.09	<0.8	15.8	8.6	<0.4	52.1
	10	17	0.11	0.04	<0.4	0.5	21.9	35.0	0.09	1410	1.06	<0.4	<2	0.12	<0.8	12.0	6.9	<0.4	55.7
	9	16	0.13	<0.04	<0.4	0.6	13.6	26.1	0.06	1450	1.00	<0.4	<2	<0.08	<0.8	14.4	7.6	<0.4	50.1
	34	17	0.38	<0.04	<0.4	0.5	18.2	55.3	0.09	1520	1.75	<0.4	<2	0.13	<0.8	60.0	8.1	<0.4	53.7
	17	32	0.15	0.05	<0.4	0.6	17.3	34.4	0.18	1410	1.05	<0.4	<2	<0.08	<0.8	11.6	8.1	<0.4	56.0

APPENDIX IIB Tissue Trace Metal Concentrations - Raw Data - Vancouver Harbour, October 1985

Station	Concentration (µg/g, dry weight)																		
	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	Ti	V	Zn
- HEPATOPANCREAS																			
	17	15	<0.2	4.8	<0.8	<0.8	405	86	0.10	450	6.0	<0.8	<3	<0.2	3	7.4	3.6	<0.8	68.8
	20	12	0.2	2.7	<0.7	<0.7	290	232	0.09	380	5.1	1.0	<3	0.2	1	8.0	4.1	<0.7	67.0
	11	15	<0.2	3.2	<0.8	<0.8	232	139	0.17	490	6.6	1.8	<3	0.3	<2	8.6	3.9	<0.8	66.0
	14	10	0.2	1.9	<0.7	0.8	169	162	0.15	360	5.0	<0.7	<3	0.2	<1	7.2	3.1	<0.7	57.7
COONSTRIPE SHRIMP (Pandalus danae) - MUSCLE																			
	21	11	0.12	<0.04	<0.4	0.6	24.8	39.0	0.20	1440	1.23	<0.4	<2	0.09	<0.8	13.20	8.1	<0.4	45.9
	15	14	0.10	0.04	<0.4	0.5	23.0	30.7	0.26	1410	1.07	<0.4	<2	<0.08	<0.8	9.26	7.8	<0.4	49.2
	5	14	0.09	<0.04	<0.4	0.7	21.2	19.5	0.24	1360	0.92	0.6	<2	<0.08	<0.8	8.64	7.6	<0.4	49.8
	8	17	0.10	<0.04	<0.4	0.5	26.1	23.2	0.40	1360	1.03	<0.4	<2	<0.08	<0.8	9.23	7.9	<0.4	48.4
	10	9	<0.08	0.04	<0.4	<0.4	16.2	24.7	0.20	1420	0.85	0.6	<2	0.11	<0.8	10.30	4.0	<0.4	39.1
	12	19	0.10	0.06	<0.4	0.6	21.1	28.2	0.31	1560	1.08	<0.4	<2	<0.08	<0.8	11.50	7.1	<0.4	52.1
- HEPATOPANCREAS																			
	<8	10	<0.2	3.7	<0.8	1.0	312	193	0.17	430	4.9	<0.8	<3	1.8	<2	6.5	3.2	<0.8	82.5
	<7	22	0.2	18.4	1.0	<0.7	490	389	0.20	520	5.7	<0.7	<3	0.4	<1	8.9	3.7	<0.7	74.0
	8	20	<0.2	2.3	1.6	<0.8	365	453	0.16	460	6.0	<0.8	<3	1.9	<2	8.9	4.0	<0.8	77.1
	7	21	<0.1	4.3	1.4	<0.7	128	478	0.14	480	4.9	<0.7	<3	0.5	<1	8.9	3.7	<0.7	64.6
SMOOTH PINK SHRIMP (Pandalus jordani) - MUSCLE																			
	5	22	<0.08	<0.04	<0.4	<0.4	24.6	16.4	0.29	1390	0.99	<0.4	<2	<0.08	<0.8	12.2	7.8	<0.4	46.6
	15	16	0.12	<0.04	<0.4	0.7	22.3	32.1	0.22	1390	1.13	<0.4	<2	0.11	<0.8	12.7	7.6	<0.4	45.7
	19	19	0.11	<0.04	<0.4	0.5	18.4	39.3	0.29	1440	1.20	<0.4	<2	<0.08	<0.8	10.2	8.9	<0.4	49.1
	10	18	<0.08	<0.04	<0.4	0.6	18.1	29.0	0.21	1380	0.97	<0.4	<2	0.09	<0.8	9.0	3.1	<0.4	42.3
	19	19	0.12	<0.04	<0.4	0.8	19.4	44.2	0.18	1350	1.23	<0.4	<2	<0.08	<0.8	10.6	4.4	<0.4	46.0
	16	20	0.09	<0.04	<0.4	0.9	20.1	39.4	0.23	1410	1.15	<0.4	<2	<0.08	<0.8	9.9	4.7	<0.4	48.1
- HEPATOPANCREAS																			
	<7	<7	<0.1	0.6	<0.7	<0.7	153	69.3	0.09	160	3.4	0.8	<3	0.5	<1	2.8	7.6	<0.7	37.0
	<7	<7	<0.1	0.8	<0.7	0.8	147	54.5	0.11	190	3.3	<0.7	<3	0.4	3	2.7	7.5	<0.7	36.5

APPENDIX IIB Tissue Trace Metal Concentrations - Raw Data - Vancouver Harbour, October 1985

	Concentration (µg/g, dry weight)																	
Station	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	Ti	V	Zn
- HEPATOPANCREAS (continued)																			
	<7	<7	0.2	0.9	<0.7	1.3	101	41.1	0.07	150	3.0	<0.7	<3	0.5	<1	1.9	8.1	<0.7	44.9
	<7	<7	<0.1	0.8	<0.7	<0.7	188	53.6	0.07	170	2.5	<0.7	<3	0.3	<1	2.9	7.9	<0.7	29.4
	<8	<8	<0.2	1.5	<0.8	<0.8	118	65.2	0.06	180	2.9	<0.8	<3	0.5	<2	2.7	7.8	<0.8	27.8
STERLING (ST)																			
COONSTRIPE SHRIMP (Pandalus danae) - MUSCLE																			
	10	24	0.23	0.07	<0.4	0.8	19.5	17.0	0.25	1500	1.10	<0.4	<2	<0.08	<0.8	25.5	7.3	<0.4	49.6
	11	13	0.11	0.10	<0.4	0.6	18.2	26.6	0.28	1420	1.50	<0.4	<2	0.34	<0.8	6.24	5.5	<0.4	44.8
	10	28	0.14	0.09	<0.4	1.0	24.7	19.6	0.24	1520	1.28	<0.4	<2	<0.08	<0.8	8.48	8.1	<0.4	63.3
	16	20	0.18	0.07	0.5	1.6	18.9	30.3	0.11	1560	1.15	<0.4	<2	0.19	<0.8	10.20	7.1	<0.4	54.1
	10	14	0.12	0.05	<0.4	0.6	21.2	22.9	0.10	1460	1.01	0.8	<2	<0.08	<0.8	11.20	6.3	<0.4	49.2
	19	23	0.20	0.09	<0.7	0.9	19.5	31.4	0.13	1570	1.20	<0.7	<3	<0.10	<1.0	18.80	5.6	<0.7	51.5
- HEPATOPANCREAS																			
	18	29	0.2	14.20	4.4	<0.8	293	553	0.12	570	8.9	2.9	3	0.50	<2	8.20	3.9	1.3	72.1
	23	23	0.3	4.00	1.2	<0.8	279	344	0.10	560	6.1	2.0	<3	0.60	<2	9.60	3.5	0.8	70.3
	13	30	0.4	7.90	3.6	1.0	520	848	0.07	780	9.4	4.1	<3	<0.20	<2	12.60	6.7	1.0	86.3
	34	16	0.3	2.70	1.6	0.9	313	424	0.18	550	6.4	2.9	<3	0.30	<1	8.70	5.8	<0.7	64.3
	15	22	0.3	9.60	2.5	2.4	296	627	0.15	660	7.7	2.3	<3	0.50	<2	10.70	7.1	2.6	78.8
PORT MOODY (PM)																			
COONSTRIPE SHRIMP (Pandalus danae) - MUSCLE																			
	14	15	0.9	0.28	<0.7	1.3	19.9	30.3	0.12	1620	1.10	<0.7	<3	<0.20	<1	32.00	4.6	<0.7	55.9
	30	9	0.4	0.29	<0.8	<0.8	20.6	57.5	0.11	1540	1.20	<0.8	<3	0.30	<2	11.40	4.8	<0.8	60.8
	15	10	0.2	0.34	<0.7	0.9	21.8	29.1	0.10	1470	1.10	<0.7	<3	0.20	<1	7.10	6.2	<0.7	54.9
	21	14	0.9	0.15	<0.8	1.3	20.9	49.6	0.09	1850	1.60	1.1	<3	<0.20	<2	100.00	6.8	<0.8	54.4
	14	13	0.4	0.15	0.4	0.7	20.9	26.7	0.10	1630	1.09	<0.4	<2	<0.08	<0.8	37.60	7.3	<0.4	54.5
	16	16	0.3	0.24	0.5	0.8	17.9	42.2	0.11	1480	0.97	<0.4	<2	<0.08	<0.8	11.40	6.8	<0.4	50.0

APPENDIX IIB Tissue Trace Metal Concentrations - Raw Data - Vancouver Harbour, October 1985

	Concentration (µg/g, dry weight)																		
Station	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	Ti	V	Zn
							- HEPATOPANCREAS												
	11	10	0.3	2.40	2.30	1.0	910	744	0.04	700	6.40	1.7	<4	<0.20	<2	14.50	5.8	<0.9	84.6
	9	24	0.5	3.90	3.70	1.1	589	872	0.10	640	6.90	2.9	<3	0.30	<1	11.30	6.1	<0.7	91.3
	8	17	0.5	2.50	2.90	1.5	715	601	0.09	630	7.00	2.9	<3	0.50	<1	13.50	5.8	3.7	90.3
	17	19	0.2	1.70	5.00	1.2	402	666	0.08	630	6.50	1.8	<3	0.30	<1	15.10	6.7	<0.7	79.5
	9	32	0.2	4.70	3.60	0.8	681	898	0.15	680	7.70	2.4	<3	0.30	<1	13.00	5.8	<0.7	102.0
	14	13	0.4	2.90	2.20	0.7	352	677	0.09	670	6.80	2.9	<3	0.30	<1	13.40	5.3	<0.7	81.6

CRAB

PACIFIC ENVIRONMENT INSTITUTE (PEI)

TANNER CRAB (Chionocetes bairdi) - MUSCLE

Station	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	Ti	V	Zn
	38	65	0.22	0.07	<0.4	0.6	44.8	71.4	0.23	1860	1.23	<0.4	<2	0.33	<0.8	11.5	7.2	<0.4	104
	8	58	0.13	0.07	<0.4	0.7	53.1	32.4	0.20	1900	0.82	<0.4	<2	0.12	<0.8	16.4	7.8	<0.4	119
						- HEPATOPANCREAS													
	53	41	0.45	8.7	<0.4	0.6	272	1450	0.29	1090	6.00	2.7	<2	0.34	<0.8	15.9	10.8	0.8	105
	13	46	0.35	8.7	1.7	0.5	429	1360	0.30	1010	3.67	1.7	<2	0.32	<0.8	23.7	8.1	0.6	105
						- GILL													
	2110	55	8.59	20.1	7.8	8.0	322	8580	0.46	7450	47.8	4.2	3	17	<0.8	96.2	101	15.4	146
	3060	49	14.80	15.2	19.0	11.6	327	12900	0.54	9370	68.6	0.9	5	32	<2	124	152	22.8	162

BURRARD YARROWS (BY)

DUNGENESS CRAB (Cancer magister) - MUSCLE

Station	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	Ti	V	Zn
	21	25	0.29	<0.04	<0.4	0.9	67.7	52.2	0.53	1990	1.35	<0.4	<2	<0.08	<0.8	58.5	7.6	<0.4	169
	10	21	0.20	<0.04	<0.4	0.8	44.4	38.9	0.47	1750	1.00	<0.4	<2	0.14	<0.8	33.0	7.3	<0.4	162
	15	12	0.31	<0.04	<0.4	0.9	36.1	44.2	0.28	1670	1.31	<0.4	<2	0.17	<0.8	47.7	9.0	<0.4	210
	29	24	0.45	<0.04	<0.4	0.8	89.9	111.0	0.19	1590	1.52	<0.4	<2	0.23	2.2	46.3	10.5	<0.4	199
	16	16	0.13	<0.04	<0.4	0.8	35.2	48.2	0.21	1690	0.92	<0.4	<2	0.13	<0.8	15.3	7.2	<0.4	151
	22	31	0.23	0.09	<0.4	0.8	59.0	65.2	0.16	1630	1.10	0.6	<2	0.30	<0.8	15.4	8.4	<0.4	196

APPENDIX IIB Tissue Trace Metal Concentrations - Raw Data - Vancouver Harbour, October 1985

	Concentration (µg/g, dry weight)																	
Station	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	Ti	V	Zn
- HEPATOPANCREAS																			
	<4	17	0.18	2.7	0.6	0.6	31.6	102	0.21	793	4.34	0.6	<2	0.13	<0.8	14.8	7.0	9.8	80.2
	5	20	0.58	3.9	1.5	0.8	274.0	224	0.32	1760	5.18	1.7	3	0.53	<0.8	55.7	8.2	1.3	153
	<4	14	0.42	6.2	1.8	0.9	321.0	224	0.42	1170	5.34	1.5	2	0.48	3.6	49.3	9.0	0.7	149
	6	21	1.12	0.6	0.8	0.8	89.1	291	0.17	2000	4.19	0.5	<2	0.33	4.5	346.0	8.6	<0.4	62.8
	<4	16	0.59	3.3	1.2	0.8	254.0	179	0.21	1490	7.49	0.7	<2	0.27	<0.8	85.1	7.7	4.2	120
	5	27	0.66	2.1	1.7	1.4	168.0	208	0.17	1910	6.99	1.7	3	0.64	<0.8	262.0	7.3	2	99.4
- GILL																			
	200	11	2.66	0.25	1.1	1.5	192	1230	0.18	6040	6.65	2.0	<2	8	<0.8	232	15.6	3.4	120
	497	14	6.15	0.8	2.9	3.5	144	3840	0.25	5050	11.50	2.4	<2	36	<0.8	154	35.2	6.9	230
	262	11	6.71	0.7	12.6	3.4	278	3180	0.19	5740	8.11	<0.4	<2	32	1.2	192	25.9	5.0	271
	1420	28	14.0	0.5	13.9	8.6	291	11100	0.21	6370	29.80	13.7	<2	86	<0.8	198	74.7	17.8	223
	380	13	6.04	0.5	3.0	3.7	185	3790	0.16	5100	10.20	3.1	<2	36	<0.8	150	30.7	6.1	173
	364	17	6.45	0.5	8.3	3.0	431	2270	0.13	5180	9.37	0.5	<2	24	<0.8	138	31.6	3.9	303
COAL HARBOUR (CH)																			
DUNGENESS CRAB (Cancer magister) - MUSCLE																			
	16	18	0.20	<0.04	0.6	0.8	84.6	56.4	0.21	1650	1.11	0.8	<2	0.16	<0.8	22.0	9.5	<0.4	233
	32	20	0.44	<0.04	<0.4	0.7	75.1	68.6	0.48	2600	1.43	0.6	<2	0.32	<0.8	111.0	8.8	<0.4	221
	7	20	0.13	<0.04	<0.4	0.9	99.8	44.0	0.22	1570	1.10	<0.4	<2	0.13	<0.8	21.2	8	<0.4	181
	5	14	0.13	<0.04	<0.4	0.8	58.5	33.0	0.66	1330	0.87	<0.4	<2	0.15	<0.8	11.7	7.3	<0.4	183
	15	21	0.20	<0.04	<0.4	0.6	61.9	58.6	0.27	1310	1.08	<0.4	<2	0.17	<0.8	18.3	7.6	<0.4	196
- HEPATOPANCREAS																			
	12	12	0.61	1.0	0.8	1.0	84.8	217.0	0.14	2070	6.61	1.0	<2	0.43	<0.8	266	6.6	0.6	85.5
	<8	13	0.40	1.7	<0.8	<0.8	171.0	131.0	0.21	1460	3.40	1.0	<3	0.20	<2	28.6	26.4	2.2	80.9
	65	16	0.99	1.9	1.3	1.4	102.0	323.0	0.15	2030	10.20	0.6	<2	0.60	<0.8	310	10.8	0.7	92.6
	<4	10	0.42	1.7	<0.4	0.9	26.0	78.6	0.23	1320	3.96	<0.4	<2	0.31	<0.8	209	7.5	0.5	53.3
	<4	11	0.36	0.8	1.0	0.6	83.2	104.0	0.15	1390	9.02	0.5	<2	0.34	<0.8	171	6.2	0.5	65.0

APPENDIX IIB   Tissue Trace Metal Concentrations - Raw Data - Vancouver Harbour, October 1985

	Concentration (µg/g, dry weight)																		
Station	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	Ti	V	Zn
- GILL																			
	835	18	8.96	0.50	10.5	4.4	440	4500	0.20	4840	16.40	<0.4	<2	49	<0.8	133	56.7	7.8	324
	516	14	4.53	0.60	2.8	2.4	155	1150	0.21	6000	13.30	<0.4	3	6	<0.8	218	36.3	3	143
	393	12	7.50	0.44	5.3	4.1	340	5040	0.22	4080	9.40	1.2	<3	49	<1	172	51.9	8.1	203
	770	9	7.79	0.40	10.9	3.4	220	3090	0.23	3470	17.50	<0.4	<2	27	<0.8	124	51.7	5.4	157
	305	9	3.44	0.28	3.3	1.8	444	1440	0.17	3980	7.75	1.2	<2	14	<0.8	92.5	24.1	2.5	237
STERLING (ST)																			
DUNGENESS CRAB (Cancer magister) - MUSCLE																			
	18	31	0.23	0.06	<0.4	0.8	73.1	50.1	0.99	1350	1.26	0.6	<2	0.26	<0.8	36.2	7.3	<0.4	178
	8	37	0.15	0.04	0.4	0.6	39.4	31.2	0.42	1190	0.74	<0.4	<2	0.18	<0.8	24.4	6.4	<0.4	160
	19	24	0.22	<0.04	<0.4	0.6	52.4	54.6	0.34	1480	1.18	<0.4	<2	0.18	<0.8	25.5	6.9	<0.4	213
	40	23	0.39	0.06	<0.4	0.8	51.1	116.0	0.72	1350	1.53	<0.4	<2	0.23	<0.8	35.9	7.9	<0.4	183
	11	33	0.24	0.04	<0.4	0.7	79.1	52.5	0.70	1400	1.46	<0.4	<2	0.10	<0.8	21.2	8.0	<0.4	191
	12	21	0.17	<0.04	<0.4	0.7	55.6	52.5	0.32	1290	1.00	<0.4	<2	0.15	<0.8	18.2	8.1	<0.4	165
- HEPATOPANCREAS																			
	9	16	0.17	1.9	0.7	0.6	139.0	95.0	0.50	1020	4.37	0.9	<2	0.18	<0.8	25.1	7.6	1.8	63.6
	11	23	0.46	1.7	1.3	0.7	204.0	179.0	0.36	1400	6.20	1.4	2	0.49	<0.8	80.5	7.2	0.7	94.9
	9	21	0.40	3.1	1.7	1.0	83.7	187.0	0.24	1380	4.90	<0.8	<3	0.30	<2	24.5	5.9	3.7	92.6
	26	15	0.68	0.4	0.9	0.9	67.4	183.0	0.20	1240	4.78	<0.4	<2	0.19	<0.8	198	7.7	<0.4	52.8
	5	19	0.41	3.8	<0.4	0.8	25.4	67.0	0.25	1260	4.27	<0.4	<2	<0.08	<0.8	208	8.4	<0.4	47.6
	6	30	0.47	0.8	<0.4	0.9	44.4	93.8	0.14	1460	6.50	<0.4	<2	0.31	<0.8	236	6.9	<0.4	50.6
- GILL																			
	239	22	2.38	0.60	2.5	1.2	284	711	0.48	4630	7.55	<0.4	<2	2.7	<0.8	120	17.7	2.3	137
	441	15	4.81	0.60	6.5	2.9	325	2880	0.35	4760	11.20	1.7	<2	27.0	<0.8	135	33.2	5.2	252
	118	10	1.91	0.36	1.3	1.0	307	703	0.26	4850	4.49	0.4	<2	3.0	<0.8	114	11.4	1.7	216
	491	17	5.79	0.43	3.1	2.8	402	2010	0.31	3020	11.80	<0.4	2	16.0	<0.9	120	37.4	3.3	222
	325	18	4.34	0.37	6.6	2.4	479	2010	0.33	4600	10.40	<0.4	<2	17.0	<0.8	196	27.6	3.9	213
	513	17	5.92	0.50	6.9	2.9	431	2370	0.23	3750	13.40	0.4	<2	19.0	<0.8	123	38.0	3.5	214

APPENDIX IIB   Tissue Trace Metal Concentrations - Raw Data - Vancouver Harbour, October 1985

Station	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	Ti	V	Zn
							Concentration (μg/g, dry weight)												
PORT MOODY (PM)																			
DUNGENESS CRAB (Cancer magister) - MUSCLE																			
	25	22	0.37	0.05	<0.4	0.9	39.4	74.2	0.39	1630	1.28	0.7	<2	0.20	<0.8	49.3	7.4	<0.4	200
	13	25	0.17	0.08	<0.4	0.7	56.8	50.3	0.34	1430	0.83	<0.4	<2	0.17	<0.8	12.7	7.4	<0.4	163
	25	<4	0.26	<0.04	<0.4	0.6	42.5	59.6	0.12	2370	1.29	<0.4	<2	0.24	<0.8	68.4	7.6	<0.4	162
	20	<4	0.33	<0.04	<0.4	0.8	25.5	58.1	0.08	1660	1.34	<0.4	<2	<0.08	<0.8	42.1	8.1	<0.4	174
	27	8	0.23	<0.04	<0.4	0.4	33.0	66.8	0.10	2050	1.32	<0.4	<2	0.18	<0.8	54.2	7.7	<0.4	178
	38	<8	0.40	<0.08	<0.8	1.2	67.5	83.8	0.09	2350	1.60	<0.8	<3	<3	<2	108.0	7.5	<0.8	201
- HEPATOPANCREAS																			
	23	23	0.57	1.9	1.0	0.8	273.0	204	0.23	1480	7.71	0.4	<2	0.45	<0.8	78.9	7.9	0.5	97.2
	14	20	0.75	1.7	0.9	0.7	226.0	164	0.47	1560	7.33	0.4	<2	0.28	<0.8	136	8.2	0.4	108
	15	11	0.99	2.2	<0.4	1.5	17.2	152	0.12	8850	7.91	0.7	<2	0.40	<0.8	164	7.4	<0.4	129
	81	10	1.29	3.1	1.0	1.0	20.5	217	0.22	1920	7.09	1.4	<2	0.31	<0.8	227	10.1	0.6	145
	51	9	1.30	2.6	0.7	1.1	20.2	210	0.13	7030	5.27	<0.4	<2	0.33	<0.8	149	7.8	<0.4	144
	20	20	0.78	2.5	0.6	1.2	18.2	150	0.19	6580	4.15	0.8	<2	0.36	<0.8	65.7	7.7	0.4	85.5
- GILL																			
	533	11	6.30	0.80	2.4	3.5	267.0	2950	0.17	3430	11.8	1.1	<3	29.0	<1	129	31.3	4.3	204
	700	16	8.28	0.60	8.2	4.4	334.0	3880	0.32	3970	15.1	<0.4	<2	34.0	<0.8	194	48.0	5.3	235
	129	<8	1.30	0.22	0.9	1.3	98.6	311	0.09	4780	5.7	<0.8	<3	<0.08	<2	117	9.8	<0.8	108
	170	<7	1.60	0.39	1.5	2.0	126.0	606	0.13	4710	5.6	2.2	<3	<3	<1	90.4	11.0	1.0	208
	70	<7	1.30	0.60	<0.7	1.3	79.2	174	0.12	3630	4.2	<0.7	<3	0.8	<1	119	24.5	<0.7	109
	101	<7	1.10	0.70	1.2	1.1	143.0	229	0.18	4410	5.1	<0.7	<3	0.7	<1	115	9.4	<0.7	110
SOLE																			
PACIFIC ENVIRONMENT INSTITUTE (PEI)																			
ENGLISH SOLE (Parophrys vetulus) - MUSCLE																			
	<4	17	<0.08	<0.04	0.6	0.5	1.1	9.2	0.69	1380	0.41	<0.4	2	<0.08	<0.8	2.17	0.8	<0.4	23.8
	14	26	<0.08	<0.04	<0.4	0.7	2.4	24.6	0.50	1260	0.58	0.6	<2	<0.08	<0.8	2.38	0.7	<0.4	19.6

APPENDIX IIB Tissue Trace Metal Concentrations - Raw Data - Vancouver Harbour, October 1985

	Concentration (µg/g, dry weight)																	
Station	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	Ti	V	Zn
- MUSCLE (continued)																			
	11	35	<0.08	<0.04	<0.4	0.6	2.4	12.0	0.51	1160	0.47	<0.4	<2	<0.08	<0.8	1.35	0.2	<0.4	20.2
	10	32	<0.08	<0.04	<0.4	1.3	3.2	11.7	0.29	1350	0.50	<0.4	<2	<0.08	<0.8	1.28	0.7	<0.4	18.9
	10	93	<0.08	<0.04	<0.4	0.5	1.2	10.1	0.28	1330	0.60	<0.4	<2	<0.08	<0.8	3.89	0.6	<0.4	21.3
	18	18	<0.08	<0.04	<0.4	0.7	3.7	18.9	0.62	1350	0.56	<0.4	<2	<0.08	<0.8	1.68	0.3	<0.4	18.8
- LIVER																			
	8	17	<0.08	5.3	5.4	0.7	71.4	1570	0.65	1050	7.76	<0.4	<2	0.55	<0.8	2.74	5.4	21.1	197.0
	10	23	<0.08	2.2	4.3	0.8	98.5	1210	0.36	1310	6.40	<0.4	<2	0.64	<0.8	2.90	9.7	1.9	116.0
	10	28	<0.08	2.4	7.1	1.0	78.5	1660	0.39	978	6.67	<0.4	<2	5.00	<0.8	2.37	9.8	4.2	228.0
	18	20	0.10	1.2	1.2	1.0	67.3	388	0.15	1200	9.66	<0.4	<2	0.45	<0.8	4.61	5.4	0.5	220.0
	17	74	<0.08	1.0	2.7	0.6	39.6	646	0.19	862	5.96	<0.4	<2	0.63	<0.8	1.90	0.4	1.5	163.0
	16	27	<0.08	3.1	7.6	0.5	29.4	1390	0.47	453	2.15	<0.4	<2	1.21	<0.8	1.65	0.7	3.0	92.8
- GILL																			
	77	5	3.22	0.06	0.7	1.2	3.3	216	0.16	1300	25.9	<0.4	<2	0.11	<0.8	290	6.1	5.0	66.5
	56	<4	1.89	0.04	0.9	1.5	3.7	290	0.14	1460	23.2	<0.4	<2	0.13	<0.8	260	0.9	1.1	62.3
	675	6	1.45	<0.04	0.5	2.0	6.6	177	0.10	1200	20.4	<0.4	<2	<0.08	<0.8	252	5.1	1.3	66.5
	655	<4	2.68	<0.04	0.7	1.6	5.0	264	0.09	1390	20.3	<0.4	<2	<0.08	<0.8	274	5.4	0.7	73.0
	585	6	1.75	<0.04	1.1	1.5	4.2	264	0.12	1370	14.2	<0.4	<2	<0.08	<0.8	285	5.3	1.1	63.0
	893	6	3.89	<0.04	0.8	1.2	4.9	222	0.19	1230	18.1	<0.4	<2	<0.08	<0.8	317	4.9	0.9	69.8
REX SOLE (Glyptocephalus zachirus) - MUSCLE																			
	14	75	0.12	<0.04	<0.4	0.7	0.7	26.7	0.23	1210	2.16	<0.4	<2	0.11	<0.8	8.86	0.5	<0.4	18.2
	5	66	0.16	<0.04	<0.4	0.6	0.6	9.2	0.21	1220	1.51	<0.4	<2	0.08	<0.8	14.50	0.7	<0.4	15.4
FLATHEAD SOLE (Hippoglossoides ellasodon) - MUSCLE																			
	21	40	0.10	0.06	<0.4	0.6	2.1	23.1	0.47	1480	1.30	<0.4	<2	0.09	<0.8	3.93	0.7	<0.4	19.3
	79	59	0.22	<0.04	<0.4	0.7	2.7	53.8	0.85	1670	1.95	<0.4	<2	0.11	<0.8	17.40	1.6	<0.4	19.1
	26	51	<0.08	<0.04	<0.4	<0.4	1.4	15.8	0.44	1320	0.79	<0.4	<2	0.21	<0.8	2.52	0.3	<0.4	17.1

APPENDIX IIB Tissue Trace Metal Concentrations - Raw Data - Vancouver Harbour, October 1985

Station	Concentration (µg/g, dry weight)																		
	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	Ti	V	Zn
- LIVER																			
	8	14	<0.08	0.5	1.5	2.5	23.9	241	0.09	341	2.73	<0.4	<2	0.13	<0.8	0.60	1.0	<0.4	94.6
	6	22	<0.08	1.1	1.7	0.4	20.7	374	0.20	458	3.82	<0.4	<2	0.09	<0.8	1.58	0.9	<0.4	102.0
	26	20	0.14	1.4	2.2	0.9	36.1	445	0.23	677	4.61	<0.4	<2	0.20	<0.8	3.40	5.7	<0.4	103.0
- GILL																			
	784	8	2.32	0.05	<0.4	1.6	7.4	142	0.05	1600	15.9	<0.4	<2	<0.08	<0.8	331	<0.2	0.4	71.0
	387	10	1.48	<0.04	0.5	1.4	7.4	211	0.15	1600	14.0	<0.4	<2	0.12	<0.8	261	0.5	<0.4	70.4
	235	13	2.78	0.06	0.7	1.4	6.0	201	0.11	1620	10.6	<0.4	<2	0.17	<0.8	234	5.9	<0.4	101.0
DOVER SOLE (*Microstomus pacifica*) - MUSCLE																			
	10	61	0.38	<0.04	<0.4	0.6	1.9	11.9	0.13	1390	1.05	<0.4	<2	<0.08	<0.8	15.00	0.8	<0.4	18.7
	13	77	<0.08	<0.04	<0.4	0.5	1.7	14.6	0.13	1270	0.75	<0.4	<2	<0.08	<0.8	1.35	0.7	<0.4	18.7
	35	76	<0.08	<0.04	<0.4	0.5	1.6	21.4	0.18	1300	0.93	<0.4	<2	<0.08	<0.8	1.63	0.8	<0.4	18.7
	89	107	0.48	<0.04	0.6	0.8	3.1	156.0	0.12	1370	2.66	<0.4	<2	0.12	<0.8	15.10	7.8	<0.4	22.8
	7	37	0.09	<0.04	<0.4	0.4	1.8	16.7	0.26	1290	0.88	<0.4	<2	<0.08	<0.8	7.01	0.7	<0.4	19.0
	17	56	<0.08	<0.04	<0.4	0.4	2.0	24.7	0.20	1130	0.87	<0.4	<2	<0.08	<0.8	2.64	2.8	<0.4	16.9
- LIVER																			
	30	9	0.30	4.4	3.9	<0.7	23.8	1180	-	1020	5.50	<0.7	<3	1.63	<1.0	11.8	9.0	<0.7	141.0
	51	8	0.23	0.6	3.7	1.1	17.0	1020	0.12	733	4.69	<0.4	<2	9.00	<0.8	2.24	6.6	0.5	115.0
	28	6	0.13	1.4	2.3	0.8	13.7	610	-	869	4.63	<0.3	2	8.00	<0.7	2.55	5.0	<0.3	102.0
	7	5	<0.08	2.7	1.9	0.5	12.7	490	0.34	492	2.37	<0.4	3	0.68	<0.8	1.72	6.1	<0.4	75.9
	32	7	<0.06	2.2	1.0	0.6	19.2	271	-	628	3.47	<0.3	<1	2.00	<0.6	1.45	3.6	<0.3	82.6
	12	7	<0.08	0.8	1.0	0.5	19.8	306	0.22	482	2.58	<0.4	<2	0.51	<0.8	0.96	6.4	<0.4	74.9
- GILL																			
	66	<4	1.88	<0.04	0.9	1.1	4.4	283	-	1310	7.89	<0.4	<1	<0.08	<0.7	171	2.8	0.5	58.1
	1920	6	1.70	<0.04	2.5	1.5	13.8	634	0.05	1430	8.52	<0.4	<2	0.21	<0.8	155	7.3	1.2	80.9
	244	6	2.64	0.04	1.8	1.6	7.6	555	0.06	1550	9.08	<0.4	<2	0.25	<0.8	218	6.5	1.0	71.6
	67	5	2.21	0.10	0.9	1.4	4.6	236	0.08	1620	6.76	<0.4	<2	0.09	<0.8	247	5.3	1.3	84.1

APPENDIX IIB   Tissue Trace Metal Concentrations - Raw Data - Vancouver Harbour, October 1985

Station	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	Ti	V	Zn
									Concentration (µg/g, dry weight)										
- GILL (continued)																			
	83	<5	2.10	0.05	1.4	1.3	3.0	382	-	1260	9.30	<0.5	<2	<0.08	<1.0	207	6.1	0.8	63.4
	424	5	2.76	0.09	2.8	2.4	29.5	748	0.08	1620	16.30	<0.4	<2	0.17	<0.8	194	13.2	1.8	69.9
BURRARD YARROWS (BY)																			
ENGLISH SOLE (Parophrys vetulus) - MUSCLE																			
	10	71	<0.08	<0.04	<0.4	0.6	1.5	22.6	0.21	1320	0.56	<0.4	<2	<0.08	<0.8	3.59	0.7	<0.4	20.5
	12	34	0.58	<0.04	<0.4	0.8	2.4	28.5	0.30	1300	3.17	<0.4	<2	0.15	<0.8	86.10	4.6	<0.4	34.7
	9	35	0.31	<0.04	<0.4	0.6	0.4	18.7	0.12	1020	2.08	<0.4	<2	0.17	<0.8	51.40	5.1	<0.4	20.2
	8	72	<0.08	<0.04	<0.4	0.5	0.9	24.6	0.32	1050	0.56	<0.4	<2	<0.08	<0.8	1.58	5.4	<0.4	18.5
	<4	47	<0.08	<0.04	<0.4	<0.4	0.9	14.7	0.04	1070	0.48	<0.4	<2	0.16	<0.8	6.15	5.7	<0.4	16.9
	8	54	<0.08	0.05	<0.4	0.5	1.0	18.0	0.14	1240	0.46	<0.4	<2	0.09	<0.8	1.68	5.6	<0.4	18.8
- LIVER																			
	13	10	<0.08	0.9	2.0	0.7	14.3	315.0	0.05	896	4.52	<0.4	<2	7	<0.8	3.08	6.0	2.2	215
	21	14	<0.08	2.0	2.2	0.6	11.8	97.5	0.05	478	3.70	<0.4	<2	4	3.5	1.99	5.6	7.5	107
	12	5	<0.08	1.0	0.9	0.6	16.6	367.0	0.11	611	3.34	<0.4	<2	5	<0.8	2.21	6.5	1.1	121
	16	21	<0.08	0.9	1.3	0.5	13.8	308.0	0.14	523	3.51	<0.4	<2	6	<0.8	3.26	5.5	1.7	140
	7	10	<0.08	0.4	0.9	<0.4	17.2	141.0	0.07	525	3.04	<0.4	4	6	0.9	1.84	5.9	0.6	163
	11	9	<0.08	1.0	1.0	0.5	22.8	272.0	0.04	527	3.34	<0.4	<2	6	3.2	2.51	5.6	1.5	147
- GILL																			
	77	<4	1.23	<0.04	1.1	1.1	5.1	322	0.07	1300	7.22	<0.4	<2	0.32	<0.8	249	6.4	1.1	62.5
	53	<4	1.78	0.11	<0.4	1.4	3.0	243	0.08	1100	8.28	<0.4	<2	0.50	<0.8	270	5.3	1.8	74.6
	98	<4	1.32	<0.04	0.7	1.5	5.3	348	0.05	1160	8.81	<0.4	<2	0.43	<0.8	198	7.4	0.8	70.8
	80	8	1.44	0.04	<0.4	1.2	4.7	345	0.04	1120	6.76	<0.4	<2	4.00	<0.8	249	7.1	1.2	65.9
	73	<4	1.38	0.07	<0.4	1.1	4.3	271	0.04	1120	6.88	<0.4	<2	0.38	<0.8	229	6.2	0.9	63.8
	82	5	1.42	<0.04	0.8	1.5	4.7	312	0.04	1160	6.36	<0.4	<2	4.00	<0.8	239	6.2	1.1	71.8

APPENDIX IIB Tissue Trace Metal Concentrations - Raw Data - Vancouver Harbour, October 1985

Station	Concentration (µg/g, dry weight)																		
	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	Ti	V	Zn
ROCK SOLE (Lepidosetta bilineata) - MUSCLE																			
	6	36	<0.08	<0.04	<0.4	0.5	0.7	10.9	0.09	1140	0.53	<0.4	<2	<0.08	<0.8	2.14	3.9	<0.4	18.8
	5	39	<0.08	<0.04	<0.4	0.5	0.5	9.3	0.06	1010	0.78	<0.4	<2	<0.08	<0.8	10.60	5.1	<0.4	35.9
	6	26	<0.08	<0.04	<0.4	0.5	0.8	8.2	0.14	973	0.48	<0.4	<2	<0.08	<0.8	6.57	5.1	<0.4	26.9
- LIVER																			
	5	11	<0.08	1.4	2.5	0.5	54.3	1000	-	586	4.10	<0.4	<2	1.32	<0.8	1.58	3.4	<0.4	159
	6	7	<0.09	2.0	3.9	<0.5	20.3	1720	-	488	3.03	<0.5	<2	1.02	1.2	1.41	4.6	0.9	111
	8	7	<0.09	1.2	2.2	0.6	9.7	784	-	585	3.29	<0.4	<2	6.00	1.6	2.16	3.9	9.3	103
- GILL																			
	17	5	1.25	<0.04	0.5	1.7	2.3	133	0.06	1240	8.13	<0.4	<2	6.00	<0.8	276	4.0	<0.4	72.0
	19	<4	1.34	<0.04	<0.4	2.0	1.9	146	-	1310	6.48	<0.4	<2	4.00	<0.8	306	4.3	0.4	74.9
	132	<4	2.03	0.04	0.5	1.9	5.6	327	0.07	1340	6.71	<0.4	<2	6.00	<0.8	257	7.8	5.4	67.4
COAL HARBOUR (CH)																			
ENGLISH SOLE (Parophrys vetulus) - MUSCLE																			
	<4	12	<0.08	<0.04	<0.4	0.5	<0.4	10.7	0.21	735	0.30	<0.4	<2	0.10	<0.8	0.85	1.8	<0.4	12.0
	7	20	<0.08	<0.04	<0.4	<0.4	<0.4	16.8	0.17	769	0.37	<0.4	<2	0.14	1.5	2.40	2.0	<0.4	11.0
	9	31	<0.08	0.06	<0.4	0.4	<0.4	15.1	0.19	760	0.42	<0.4	<2	0.14	1.1	1.57	2.1	<0.4	13.7
	11	33	0.09	<0.04	<0.4	<0.4	<0.4	20.4	0.16	807	0.50	<0.4	<2	0.24	<0.8	2.16	<0.2	<0.4	13.4
	<4	38	<0.08	<0.04	<0.4	<0.4	<0.4	7.4	0.22	896	0.30	<0.4	<2	0.16	2.0	1.38	<0.2	<0.4	17.1
	11	28	0.10	<0.04	<0.4	0.8	<0.4	15.5	0.19	907	0.79	<0.4	<2	0.18	<0.8	8.27	<0.2	<0.4	16.3
- LIVER																			
	4	<4	<0.08	0.6	1.0	<0.4	6.7	566	0.11	276	1.46	<0.4	<2	0.55	1.7	0.76	1.9	2.1	85.6
	<8	<8	<0.2	1.2	1.7	1.0	19.1	232	0.12	490	2.60	1.3	<3	<3.0	4.0	4.10	1.0	1.3	102.0
	<5	25	<0.1	2.2	1.7	0.8	26.5	569	0.18	460	2.70	1.1	<2	4.00	3.0	1.10	<0.2	4.6	109.0
	7	15	<0.08	1.2	2.4	0.6	29.1	500	0.19	506	2.26	<0.4	<2	4.60	1.4	2.12	<0.2	1.7	136.0
	<5	14	<0.1	1.8	2.2	1.0	17.6	236	0.25	450	2.50	0.8	<2	6.00	2.0	1.00	<0.2	1.9	123.0
	6	5	<0.1	0.9	1.0	1.5	13.4	313	0.16	500	2.80	1.2	<2	5.00	<1.0	7.10	<0.2	1.4	146.0

APPENDIX IIB Tissue Trace Metal Concentrations - Raw Data - Vancouver Harbour, October 1985

Station	Concentration (µg/g, dry weight)																	
	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	Ti	V	Zn
					- GILL														
	213	<4	1.57	0.05	<0.4	1.4	2.3	319	0.07	791	7.25	0.5	<2	0.58	2.1	123	8.1	2.0	37.0
	98	5	1.08	0.13	0.4	2.0	2.3	192	0.06	858	5.62	0.8	<2	4.00	2.3	160	5.5	2.7	48.1
	150	6	1.13	0.16	0.8	2.0	3.4	333	0.06	979	8.80	0.6	<2	5.00	1.0	129	8.1	3.6	53.2
	88	5	1.39	<0.04	<0.4	2.6	2.3	173	0.08	1040	9.42	<0.4	<2	0.69	2.1	193	8.7	2.4	52.1
	223	7	1.61	<0.04	0.4	2.1	3.7	293	0.11	997	9.84	0.7	3	0.78	2.1	177	12.7	2.7	62.1
	136	5	1.4	0.05	0.4	2.7	2.7	329	0.10	1050	6.26	<0.4	<2	5.00	2.1	185	7.5	2.9	53.0
STERLING (ST)																			
ENGLISH SOLE (*Parophrys vetulus*) - MUSCLE																			
	11	116	0.29	<0.04	<0.4	1.0	1.7	22.0	0.46	1360	0.60	<0.4	<2	0.39	<0.8	6.48	<0.2	1.0	28.1
	12	72	0.19	0.06	0.8	1.3	1.8	17.1	0.23	999	0.48	<0.4	<2	4.00	<0.8	3.13	<0.2	2.4	29.7
	7	56	0.08	<0.04	<0.4	1.0	1.1	15.6	0.23	1280	0.57	<0.4	<2	0.11	<0.8	5.44	<0.2	0.8	21.2
	<4	79	<0.08	<0.04	<0.4	0.5	0.8	15.2	0.32	1280	0.58	<0.4	<2	<0.08	1.1	10.9	<0.2	<0.4	25.8
	25	56	0.26	<0.04	<0.4	0.6	1.1	59.1	0.22	1370	1.42	<0.4	<2	0.37	<0.8	26.4	0.3	<0.4	24.7
	12	43	0.15	0.04	<0.4	0.8	1.0	23.2	0.31	1050	0.56	<0.4	<2	0.16	1.7	2.87	<0.2	0.4	18.0
					- LIVER														
	34	25	0.20	5.5	1.5	1.1	21.2	105	0.25	690	3.50	1.6	<2	10.00	3.0	2.8	<0.2	8.0	116
	19	10	<0.1	2.1	2.9	0.9	10.9	150	0.15	670	3.10	1.5	<2	7.00	3.0	2.1	<0.2	4.4	142
	10	15	0.09	1.9	1.2	1.1	25.9	247	0.13	595	3.86	0.9	<2	10.00	3.5	1.8	<0.2	3.4	131
	12	11	<0.09	2.6	2.6	<0.5	20.5	239	0.17	645	3.32	0.8	<2	<2.0	7.8	2.24	<0.2	1.8	129
	58	8	0.20	3.5	5.5	0.9	35.2	1130	0.19	810	4.30	1.5	<3	8.00	2.0	3.4	<0.3	10.5	133
	33	12	0.20	3.0	4.5	0.9	20.2	338	0.21	780	3.60	1.7	<2	2.00	5.0	4.7	<0.2	4.5	107
					- GILL														
	84	8	1.69	0.50	0.7	2.9	4.0	241	0.10	1010	7.16	1.1	3	9.00	1.1	272	4.9	5.9	56.5
	200	11	2.85	<0.04	0.6	3.0	4.4	407	0.07	1470	9.95	1.2	<2	7.00	1.8	373	10.9	4.5	70.2
	276	8	2.04	0.09	0.6	2.2	5.4	458	0.08	1320	11.70	<0.4	<2	4.00	2.1	227	14.3	3.8	76.6
	161	7	2.03	0.08	<0.4	2.7	4.0	428	0.09	1380	9.98	<0.4	<2	3.00	3.4	388	9.0	4.4	74.8
	233	9	3.12	0.04	0.5	3.1	5.4	438	0.06	1600	11.00	1.1	<2	9.00	2.4	373	12.8	4.5	78.6
	61	6	1.42	0.06	0.4	2.7	2.3	190	0.10	1240	8.42	0.5	<2	4.00	3.8	277	4.9	4.0	70.4

APPENDIX IIB Tissue Trace Metal Concentrations - Raw Data - Vancouver Harbour, October 1985

	Concentration (µg/g, dry weight)																	
Station	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	Ti	V	Zn
ROCK SOLE (Lepidopsetta bilineata) - MUSCLE																			
	<4	37	<0.08	<0.04	<0.4	0.6	<0.4	9.9	0.28	1080	0.50	<0.4	<2	0.11	<0.8	1.98	<0.2	<0.4	17.2
	9	26	0.11	<0.04	<0.4	0.8	<0.4	16.3	0.39	1340	0.58	<0.4	<2	0.12	<0.8	11.2	<0.2	0.5	21.2
	<4	59	<0.08	<0.04	<0.4	<0.4	<0.4	12.4	0.33	1560	0.48	<0.4	<2	0.16	<0.8	2.06	<0.2	<0.4	19.4
	5	16	<0.08	<0.04	<0.4	<0.4	<0.4	15.2	0.20	1470	0.36	<0.4	<2	<0.08	<0.8	2.02	<0.2	<0.4	18.7
	8	38	0.08	<0.04	0.5	2.1	1.5	13.2	0.34	1540	0.69	1.3	10	0.10	<0.8	1.04	<0.2	1.1	22.1
	4	41	<0.08	<0.04	<0.4	0.7	<0.4	10.7	0.28	1510	0.67	<0.4	<2	0.09	<0.8	3.68	<0.2	<0.4	24.1
- LIVER																			
	<5	7	<0.1	1.2	0.8	0.6	36.1	585	0.21	560	2.80	1.1	<2	1.00	4.0	0.90	<0.2	1.6	215
	7	9	<0.1	2.4	<0.5	1.0	29.1	955	0.28	940	3.50	1.1	<2	1.00	5.0	3.20	<0.2	3.7	229
	6	7	<0.08	1.3	<0.4	<0.4	20.2	684	0.23	820	3.92	<0.4	<2	0.69	4.0	1.92	<0.2	<0.4	206
	15	10	0.09	1.2	<0.4	1.2	62.7	1010	0.14	917	4.84	1.8	<2	0.74	6.0	2.20	<0.2	1.6	483
	6	15	<0.08	0.7	<0.4	0.8	32.6	400	0.14	497	1.94	0.9	<2	0.37	1.0	1.39	<0.2	1.0	206
	7	12	<0.1	2.4	<0.5	0.7	25.1	1160	0.24	760	3.20	1.4	<2	1.40	5.0	1.60	<0.2	1.8	127
- GILL																			
	41	<4	1.37	0.05	<0.4	2.6	2.2	140	0.09	1530	5.62	<0.4	5	4.00	2.8	305	5.1	2.0	77.5
	32	<4	2.05	<0.04	<0.4	2.8	1.7	126	0.13	1640	7.87	0.7	<2	5.00	2.7	417	5.6	2.9	92.0
	53	6	1.88	<0.04	<0.4	3.7	2.1	161	0.14	1910	7.40	0.8	2	6.00	3.6	363	1.3	2.5	91.3
	37	<4	1.08	0.06	<0.4	3.6	2.5	127	0.08	1540	5.45	1.0	<2	6.00	2.2	274	4.6	2.9	76.1
	32	<4	1.09	<0.04	<0.4	2.3	2.6	198	0.10	1220	4.22	0.5	<2	4.00	1.9	220	0.5	2.3	63.7
	30	<4	1.51	0.06	<0.4	3.5	3.1	108	0.09	1780	7.73	1.7	<2	9.00	2.9	359	0.5	4.0	90.6
PORT MOODY (PM)																			
ENGLISH SOLE (Parophrys vetulus) - MUSCLE																			
	8	44	0.18	<0.04	<0.4	1.0	0.8	14.8	0.21	849	0.46	<0.4	<2	0.11	<0.8	6.47	<0.2	1.0	20.4
	4	59	<0.08	<0.04	<0.4	0.8	<0.4	16.2	0.28	1030	0.32	0.5	<2	0.13	<0.8	1.76	<0.2	<0.4	19.3
	10	139	0.1	<0.04	<0.4	1.3	1.4	26.3	0.11	1070	0.41	<0.4	<2	0.14	<0.8	3.17	<0.2	1.0	29.4
	7	38	<0.08	0.1	<0.4	0.9	1.6	22.8	0.23	1330	0.51	<0.4	<2	<0.08	<0.8	5.09	<0.2	0.5	30.3
	6	24	<0.08	<0.04	<0.4	0.8	1.1	18.1	0.08	1270	0.46	<0.4	<2	<0.08	<0.8	2.17	<0.2	0.9	23.1
	7	40	0.14	<0.04	<0.4	1.1	1.2	12.9	0.15	1050	0.55	<0.4	<2	<0.08	<0.8	4.94	<0.2	1.5	19.2

APPENDIX IIB Tissue Trace Metal Concentrations - Raw Data - Vancouver Harbour, October 1985

	Concentration (µg/g, dry weight)																	
Station	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	Ti	V	Zn
					- LIVER														
	15	8	<0.08	1.1	1.2	0.9	4.8	213	0.11	524	2.15	1.1	<2	0.35	<0.8	1.21	<0.2	2.4	63.2
	70	13	0.19	2.3	4.1	1.0	7.4	490	0.16	737	4.10	0.8	<2	0.76	<0.8	6.61	1.7	4.1	84.7
	34	30	0.14	1.6	4.5	1.6	8.9	724	0.10	618	2.78	1.4	<2	6.00	2.3	1.87	<0.2	7.3	101.0
	43	11	0.08	6.3	7.8	1.1	31.1	1300	0.24	711	3.60	2.0	3	4.00	4.1	2.39	<0.2	8.2	104.0
	11	<4	0.12	1.0	2.5	1.0	20.7	667	0.05	536	3.11	1.1	<2	4.00	1.1	0.99	<0.2	3.0	125.0
	18	6	0.08	0.9	2.4	0.6	24.8	437	0.07	515	2.09	0.6	<2	3.00	1.1	1.38	<0.2	2.0	120.0
					- GILL														
	248	6	2.59	0.04	0.5	3.4	2.8	489	0.08	1420	10.50	<0.4	<2	5.00	1.2	359	10.8	4.3	68.4
	775	13	4.36	0.10	1.3	4.5	4.6	1050	0.11	1870	15.10	1.8	2	9.00	3.1	407	27.5	5.4	82.0
	256	13	2.64	0.04	<0.4	3.0	4.2	502	0.07	1510	9.00	0.6	<2	4.00	1.3	273	15.4	3.5	77.4
	270	9	3.09	0.07	0.6	2.8	4.0	549	0.05	1640	10.20	0.8	<2	5.00	<0.8	334	16.1	3.7	75.4
	325	5	1.85	0.50	1.1	3.3	4.3	548	0.04	1400	8.52	0.9	2	7.00	1.8	190	12.7	5.0	70.7
	117	7	1.59	<0.04	<0.4	2.6	3.1	410	0.05	1480	7.83	0.5	<2	5.00	1.8	233	7.6	3.0	79.2

OTHER FISH SPECIES

PACIFIC ENVIRONMENT INSTITUTE (PEI)

WALLEYE POLLOCK (Theragra chalcogramma) - MUSCLE

Station	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	Ti	V	Zn
	<4	17	<0.08	<0.04	<0.4	0.6	1.4	14.7	0.14	1360	0.85	<0.4	<2	0.11	<0.8	1.96	6.1	<0.4	14.2
	6	15	0.14	0.04	0.6	0.8	1.7	21.1	0.11	1300	1.20	<0.4	<2	0.14	<0.8	10.60	6.3	<0.4	17.0
	5	24	0.10	0.06	<0.4	0.7	1.2	18.5	0.30	1360	1.70	<0.4	<2	0.19	<0.8	9.63	6.5	<0.4	14.8
						- LIVER													
	<4	5	<0.08	0.43	<0.4	<0.4	4.8	106.0	0.06	129	3.37	<0.4	<2	0.13	<0.8	0.28	6.8	<0.4	39.9
	<4	9	<0.08	0.33	0.7	<0.4	33.7	127.0	0.06	340	6.16	0.5	<2	0.16	<0.8	2.93	6.6	<0.4	68.5
	<7	<7	<0.1	0.37	<0.7	<0.7	3.5	38.7	0.04	120	1.40	<0.7	<3	0.40	<1.0	0.90	11.9	<0.7	19.8

APPENDIX IIB Tissue Trace Metal Concentrations - Raw Data - Vancouver Harbour, October 1985

Station	Concentration (µg/g, dry weight)																	
	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	Ti	V	Zn
- GILL																			
	154	6	1.91	0.08	1.4	1.4	3.1	309	0.08	1310	27.3	<0.4	2	0.11	<0.8	118	8.7	0.5	74.7
	113	<4	1.30	0.10	0.4	1.2	2.4	243	0.02	1190	8.3	0.9	<2	0.12	<0.8	131	6.6	0.5	54.9
	83	6	1.41	0.12	0.7	1.1	6.6	257	0.11	1330	19.5	<0.4	<2	0.18	<0.8	189	5.8	<0.4	66.3
PACIFIC COD (Gadus macrocephalus) - MUSCLE																			
	<4	30	<0.08	<0.04	<0.4	0.5	0.9	7.9	0.71	1260	0.32	<0.4	2	<0.08	<0.8	0.71	6.7	<0.4	15.6
- LIVER																			
	<4	11	<0.08	0.17	0.6	0.4	4.3	97.8	0.12	166	2.86	0.9	17	0.26	<0.8	0.96	6.2	<0.4	42.9
- GILL																			
	55	5	0.43	0.11	0.9	0.6	3.8	238	0.06	745	7.79	<0.4	<2	0.14	<0.8	21.1	7.5	<0.4	52.8
DOGFISH (Squalus acanthias) - MUSCLE																			
	<4	15	<0.08	0.06	<0.4	0.5	2.0	8.9	5.12	452	0.23	<0.4	2	0.13	<0.8	0.33	6.3	<0.4	6.7
- LIVER																			
	12	10	<0.08	3.00	0.6	<0.4	4.9	175	7.02	146	1.47	1.5	<2	0.16	<0.8	0.34	4.6	<0.4	17.5
- GILL																			
	19	9	1.05	0.15	0.5	0.9	2.8	94.8	3.94	872	4.60	<0.4	<2	0.22	<0.8	58.2	7.0	<0.4	48.6
RATFISH (Hydrolagus colliei) - MUSCLE																			
	<4	61	<0.08	0.07	<0.4	0.6	1.6	12.1	0.65	1170	0.86	<0.4	<2	0.16	<0.8	0.6	6.9	<0.4	15.6
- LIVER																			
	<8	24	<0.2	0.68	1.3	<0.8	9.7	268	0.12	150	1.7	1.2	25	<3	<2	0.5	6.0	<0.8	16.6
- GILL																			
	29	22	0.4	0.14	0.8	0.7	4.2	123	0.30	907	7.93	0.5	<2	0.11	<0.8	20.3	6.8	<0.4	45.8

APPENDIX IIC Tissue Trace Metal Concentrations - Raw Data - Vancouver Harbour, January 1986

	Concentration (µg/g, dry weight)																	
Station	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	Ti	V	Zn
PACIFIC ENVIRONMENT INSTITUTE (PEI)																			
SIDESTRIPE SHRIMP (Pandalopsis dispar) - MUSCLE																			
	125	41	0.53	0.09	<0.4	0.9	14.5	237	0.23	1610	4.26	<0.4	<2	0.61	<0.8	13.5	4.4	<0.4	48.2
	119	39	0.44	0.08	<0.4	1.1	18.6	271	0.21	1740	4.31	<0.4	4	0.89	<0.8	21.9	4.0	<0.4	55.0
	129	38	0.44	0.11	<0.4	1.2	15.8	263	0.21	1720	4.21	<0.4	2	0.52	<0.8	11.5	4.1	0.6	49.7
	99	48	0.40	0.10	<0.4	0.9	23.4	205	0.24	1580	3.54	<0.4	2	0.61	<0.8	16.4	3.4	<0.4	53.8
	71	39	0.31	0.14	<0.4	1.2	15.6	188	0.04	1500	3.38	<0.4	5	0.56	<0.8	14.0	2.5	<0.4	50.2
	109	37	0.37	0.10	<0.4	1.3	17.4	231	0.17	1670	3.72	<0.4	3	0.70	<0.8	12.3	3.7	<0.4	49.5
	75	42	0.29	0.10	<0.4	2.4	19.9	215	0.07	1540	3.20	<0.4	8	0.70	<0.8	9.5	2.7	<0.4	49.1
	52	48	0.21	0.09	<0.4	1.2	16.3	142	0.23	1530	2.40	<0.4	4	0.61	<0.8	10.4	2.1	<0.4	48.2
	71	44	0.31	0.11	<0.4	0.7	13.2	143	0.17	1560	2.53	<0.4	<2	0.34	<0.8	10.1	2.4	<0.4	49.0
	74	36	0.56	0.12	<0.4	2.1	15.0	190	0.19	1520	3.06	<0.4	7	0.25	<0.8	19.9	2.7	<0.4	45.4
	67	39	0.26	0.13	<0.4	0.8	13.3	138	0.20	1650	2.38	<0.4	<2	0.40	<0.8	13.7	2.4	<0.4	46.9
	67	43	0.34	0.11	<0.4	0.9	17.7	145	0.19	1620	2.81	<0.4	3	0.50	<0.8	23.7	2.4	<0.4	49.5
- HEPATOPANCREAS																			
	128	46	0.67	31.4	<0.4	0.7	1120	305	-	678	12.60	<0.4	2	0.54	<0.7	18.2	3.4	1.0	86.3
	43	44	0.43	31.1	<0.4	0.6	1140	153	-	562	11.10	<0.4	2	0.25	<0.8	11.9	2.2	0.5	82.0
	73	51	0.59	24.5	0.5	0.7	1030	223	-	875	13.70	0.6	2	0.39	<0.6	21.8	2.6	1.0	92.5
	69	49	0.50	35.4	<0.4	0.6	1370	234	-	710	13.40	<0.4	2	<0.08	<0.8	17.5	1.9	0.6	93.2
	271	54	1.10	31.3	<0.5	1.2	1260	650	-	1030	20.60	<0.5	2	1.10	<1.0	28.0	5.1	1.5	109.0
	121	64	0.81	33.5	0.3	0.8	1650	306	-	866	16.80	<0.3	2	0.45	<0.7	18.8	1.4	0.8	114.0
CENTRE (CT)																			
COONSTRIPE SHRIMP (Pandalus danae) - MUSCLE																			
	15	25	0.08	0.08	<0.4	0.5	34.1	35.8	0.17	1480	1.04	<0.4	<2	0.68	<0.8	9.5	0.9	<0.4	64.4
	21	17	<0.08	0.07	<0.4	<0.4	29.7	39.0	0.13	1530	1.34	<0.4	<2	0.26	<0.8	11.2	0.7	<0.4	65.0
	11	20	0.14	0.08	<0.4	0.5	19.6	24.8	0.10	1530	1.04	0.6	<2	0.17	<0.8	20.1	0.8	<0.4	55.0
	8	21	<0.08	0.10	<0.4	0.5	26.1	18.4	0.14	1530	1.02	<0.4	<2	0.26	<0.8	15.8	0.6	<0.4	59.1
	18	22	0.14	0.09	<0.4	0.8	24.8	37.8	0.17	1630	1.26	<0.4	3	0.43	<0.8	14.5	1.0	<0.4	57.9
	15	24	0.11	0.09	<0.4	0.5	26.6	29.5	0.20	1520	1.08	<0.4	2	0.38	<0.8	12.8	0.8	<0.4	59.7

APPENDIX IIC Tissue Trace Metal Concentrations - Raw Data - Vancouver Harbour, January 1986

Station	Concentration (µg/g, dry weight)																		
	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	Ti	V	Zn
- HEPATOPANCREAS																			
	14	15	0.13	2.0	<0.4	0.4	292	325	-	624	6.62	0.5	<2	0.67	<0.8	11.7	0.9	0.6	90.2
	14	10	0.34	2.5	<0.4	<0.4	308	164	0.08	655	5.88	<0.4	<2	0.30	<0.8	49.6	0.7	<0.4	72.9
	13	14	0.13	3.7	<0.4	<0.4	343	173	-	535	4.68	0.6	<1	0.65	<0.7	14.4	1.5	<0.4	70.8
HUMPBACK SHRIMP (Pandalus hypsinotus) - MUSCLE																			
	7	14	<0.08	0.08	<0.4	<0.4	28.8	22.7	0.20	1600	1.06	<0.4	<2	0.44	<0.8	11.3	0.5	<0.4	93.8
	9	19	<0.08	0.15	<0.4	<0.4	29.9	29.5	0.20	1730	1.08	<0.4	<2	0.08	<0.8	15.8	0.5	<0.4	52.6
	26	16	0.13	<0.04	<0.4	<0.4	25.1	67.3	0.15	1760	1.48	<0.4	<2	0.08	<0.8	16.8	1.1	<0.4	51.5
	7	8	<0.08	0.08	<0.4	<0.4	27.0	18.7	0.13	1560	0.96	<0.4	<2	0.13	<0.8	10.5	0.5	<0.4	57.2
	13	15	0.15	0.10	<0.4	<0.4	28.6	46.6	0.18	1710	1.20	<0.4	<2	0.58	<0.8	12.2	0.7	<0.4	51.2
	30	12	0.17	0.20	<0.4	0.5	37.3	781.0	0.20	1730	5.26	<0.4	<2	0.85	<0.8	13.5	2.2	<0.4	58.9
- HEPATOPANCREAS																			
	19	20	0.47	8.0	<0.5	<0.5	835	495	-	681	6.51	<0.5	<2	0.45	<0.9	15.1	1.6	0.6	65.8
	19	22	0.50	8.7	<0.4	<0.4	833	578	-	808	8.18	<0.4	<1	1.26	<0.7	16.0	<0.1	2.2	90.7
	15	19	1.22	9.9	<0.4	0.5	567	476	-	1360	7.66	<0.4	1	0.24	<0.7	177.0	1.5	0.9	93.8
PORT MOODY (PM)																			
COONSTRIPE SHRIMP (Pandalus danae) - MUSCLE																			
	75	17	0.29	0.22	<0.4	1.0	34.1	158.0	0.18	1710	2.56	<0.4	2	0.55	<0.8	11.2	3.2	<0.4	72.6
	37	14	0.18	0.04	<0.4	0.7	18.1	69.0	0.12	1610	1.47	<0.4	<2	0.26	<0.8	13.6	1.6	<0.4	52.3
	54	11	0.22	0.04	<0.4	0.6	33.8	105.0	0.20	1680	1.97	<0.4	<2	0.42	<0.8	16.3	2.4	<0.4	56.4
	38	18	0.25	0.12	<0.4	0.5	29.5	81.2	0.31	1760	1.74	<0.4	<2	0.59	<0.8	20.4	1.9	<0.4	59.2
	117	20	0.43	0.12	<0.4	0.7	26.8	236.0	0.28	1720	3.23	<0.4	<2	0.83	<0.8	14.1	4.8	<0.4	60.4
	98	16	0.39	0.07	<0.4	0.8	35.2	177.0	0.20	1620	2.94	<0.4	<2	0.83	<0.8	15.0	3.7	<0.4	61.7
	62	14	0.43	0.10	<0.4	0.8	34.1	177.0	0.13	1800	2.88	<0.4	2	1.03	<0.8	26.0	2.5	<0.4	62.0
	44	14	0.22	0.07	<0.4	0.5	26.0	96.3	0.26	1670	2.93	<0.4	<2	0.62	<0.8	23.4	1.7	<0.4	53.3
	62	17	0.23	0.09	<0.4	1.0	37.8	170.0	0.20	1560	2.70	<0.4	3	0.38	<0.8	10.3	2.4	<0.4	58.0
	48	16	0.21	0.05	<0.4	0.7	32.6	93.5	0.24	1670	1.78	<0.4	2	0.49	<0.8	11.7	2.1	<0.4	70.3
	46	19	0.18	0.05	<0.4	0.6	30.8	108.0	0.19	1680	1.92	<0.4	<2	0.54	<0.8	9.9	1.9	<0.4	56.2
	42	14	0.47	<0.04	<0.4	0.7	26.1	71.5	0.19	1670	1.62	<0.4	3	0.54	<0.8	72.3	1.5	<0.4	52.1

APPENDIX IIC Tissue Trace Metal Concentrations - Raw Data - Vancouver Harbour, January 1986

	Concentration (µg/g, dry weight)																	
Station	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	Ti	V	Zn
- HEPATOPANCREAS																			
	26	26	0.67	3.4	<0.4	0.5	490	767	-	912	5.93	<0.4	<2	1.72	<0.9	70.9	1.2	0.6	83.0
	58	30	0.56	5.4	<0.4	0.8	1330	306	-	1350	5.70	<0.4	<1	0.11	<0.7	70.2	2.2	0.5	109.0
	24	23	0.20	4.6	<0.4	0.8	322	412	-	574	5.61	<0.4	<2	1.03	<0.8	12.6	1.0	1.1	73.5
CRAB																			
COAL HARBOUR (CH)																			
DUNGENESS CRAB (*Cancer magister*) - MUSCLE																			
	22	14	0.49	0.09	<0.4	0.7	69.5	75.2	0.733	1660	1.92	<0.4	<2	<0.08	<0.8	93.0	1.1	<0.4	186
	16	9	0.22	<0.04	<0.4	0.6	44.5	84.7	0.548	1450	1.28	<0.4	<2	<0.08	<0.8	33.7	1.0	<0.4	266
	28	12	0.27	<0.04	<0.4	0.7	35.9	69.1	0.379	1670	1.80	<0.4	<2	<0.08	<0.8	35.7	1.5	<0.4	204
	32	16	0.26	0.07	0.7	0.8	125.0	60.6	0.365	1850	1.36	<0.4	<2	0.90	<0.8	55.4	1.8	<0.4	250
	36	12	0.25	<0.04	<0.4	0.9	55.0	168.0	0.782	1820	2.56	<0.4	<2	0.53	<0.8	46.7	1.3	<0.4	185
	38	12	0.50	0.08	<0.4	1.1	63.3	234.0	0.425	1390	2.87	<0.4	<2	1.28	<0.8	16.6	1.5	<0.4	193
- HEPATOPANCREAS																			
	36	27	0.40	5.9	1.5	1.4	175.0	229	0.643	1230	6.88	0.8	2	0.61	<0.8	23.1	2.0	1.1	162.0
	25	16	0.71	2.5	0.6	0.9	106.0	365	0.561	3000	8.72	0.5	<2	0.80	<0.8	108.0	1.4	0.5	100.0
	39	60	0.86	1.6	1.0	1.0	35.5	270	0.100	2140	8.65	0.9	3	0.68	<0.8	137.0	2.0	1.0	91.4
	38	14	0.83	2.0	0.5	1.1	131.0	279	0.140	6330	5.94	<0.4	<2	0.71	<0.8	94.6	1.5	<0.4	72.3
	8	13	0.69	0.9	0.5	1.0	108.0	191	0.404	2080	3.85	<0.4	<2	0.62	<0.8	367.0	<0.2	<0.4	65.5
	8	10	0.66	1.2	<0.4	1.1	92.2	116	0.065	2270	5.48	<0.4	<2	0.57	<0.8	386.0	<0.2	<0.4	52.2
- GILL																			
	165	9	2.84	0.44	1.6	1.1	322	468	0.180	5280	6.28	<0.4	<2	2.19	<0.8	159.0	6.4	0.9	258
	218	9	5.22	0.50	1.5	2.5	232	2440	0.130	4470	6.62	<0.4	<2	29.00	<0.8	89.0	10.9	3.1	194
	786	8	5.98	0.60	2.7	2.2	233	1710	0.120	5550	20.70	<0.4	4	10.00	<0.8	95.0	28.7	3.2	182
	313	9	2.01	0.50	1.3	1.1	166	602	0.100	3320	10.90	<0.4	<2	1.55	<0.8	105.0	12.2	1.1	103
	284	5	5.21	0.35	2.5	1.9	300	1810	0.200	4390	12.50	<0.4	<2	17.00	<0.8	277.0	10.8	2.4	181
	625	10	7.81	0.50	3.0	3.5	426	3780	0.180	4610	19.50	<0.4	3	42.00	<0.8	207.0	24.9	6.0	171

APPENDIX IIC Tissue Trace Metal Concentrations - Raw Data - Vancouver Harbour, January 1986

Station	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	Ti	V	Zn
	Concentration (µg/g, dry weight)																		
BURRARD YARROWS (BY)																			
DUNGENESS CRAB (Cancer magister) - MUSCLE																			
	12	17	0.19	<0.04	<0.4	0.6	32.9	32.9	0.745	1380	1.19	<0.4	<2	<0.08	<0.8	34.7	0.3	<0.4	163
	16	15	0.13	0.05	<0.4	0.5	52.4	42.2	0.410	1860	1.17	<0.4	<2	0.17	<0.8	40.6	0.9	<0.4	275
	20	30	0.56	<0.04	<0.4	0.7	38.5	50.1	0.781	1460	1.41	<0.4	<2	<0.08	<0.8	131.0	0.8	<0.4	169
	26	16	0.19	0.10	<0.4	0.5	50.5	65.9	0.789	1650	1.55	<0.4	<2	0.26	<0.8	48.2	1.4	<0.4	291
	18	16	0.13	0.04	<0.4	0.5	90.5	54.1	0.360	1920	1.26	<0.4	<2	0.44	<0.8	43.8	0.8	<0.4	222
	16	20	0.13	0.05	<0.4	0.5	122.0	40.4	0.351	2440	1.06	<0.4	<2	0.20	<0.8	54.1	0.7	<0.4	182
- HEPATOPANCREAS																			
	6	14	0.16	2.6	<0.4	0.6	41.2	93.5	0.361	756	4.20	0.5	<2	0.21	<0.8	20.8	0.6	1.4	82.5
	9	16	0.46	0.6	<0.4	0.6	110.0	138.0	0.365	3670	3.47	<0.4	<2	<0.08	<0.8	59.9	0.7	<0.4	48.0
	24	25	0.40	3.0	1.4	1.3	285.0	196.0	0.500	1230	6.73	1.0	2	5.00	<0.8	27.9	1.4	5.9	109.0
	8	13	0.29	1.2	<0.4	<0.4	91.5	79.8	0.400	3490	3.92	<0.4	<2	0.34	<0.8	35.4	1.0	1.3	65.8
	26	16	0.59	1.1	0.7	0.6	206.0	193.0	0.310	3450	4.66	<0.4	<2	<0.08	<0.8	57.8	1.3	<0.4	86.3
	24	18	1.41	1.2	<0.4	1.2	38.3	370.0	0.360	7950	5.20	<0.4	<2	0.34	<0.8	145.0	1.1	<0.4	87.2
- GILL																			
	183	9	2.33	0.4	<0.4	1.7	253	1060	0.310	3990	7.65	<0.4	<2	8.00	<0.8	107.0	8.9	2.1	190
	72	8	0.67	0.4	0.6	0.9	242	197	0.320	4270	4.07	<0.4	<2	0.65	<0.8	95.2	3.0	0.6	114
	133	8	1.91	0.5	0.6	1.1	167	549	0.420	4370	5.88	<0.4	<2	5.00	<0.8	180.0	5.3	1.0	109
	76	11	2.14	0.5	0.6	1.3	272	630	0.420	4460	4.27	<0.4	<2	7.00	<0.8	109.0	3.8	1.1	158
	380	9	1.51	0.5	0.5	1.2	218	586	0.370	4080	8.35	<0.4	<2	2.09	<0.8	97.7	10.3	0.9	122
	90	8	0.75	0.3	0.4	0.6	240	180	0.200	4850	4.70	<0.4	<2	0.63	<0.8	99.7	3.8	<0.4	112
CENTRE (CT)																			
DUNGENESS CRAB (Cancer magister) - MUSCLE																			
	26	20	0.15	0.10	<0.4	0.6	54.9	42.6	0.842	1990	1.20	<0.4	<2	0.71	<0.8	32.9	1.0	<0.4	145
	9	18	0.13	0.04	<0.4	<0.4	61.4	32.4	0.600	1790	1.08	<0.4	<2	0.76	<0.8	35.7	0.7	<0.4	212
	13	16	0.09	0.04	<0.4	<0.4	81.6	23.1	0.380	2110	0.96	<0.4	<2	0.78	<0.8	39.8	0.2	<0.4	219
	18	13	0.30	0.04	<0.4	0.6	55.0	49.1	0.951	1930	1.28	<0.4	<2	0.76	<0.8	89.7	0.8	<0.4	270

APPENDIX IIC Tissue Trace Metal Concentrations - Raw Data - Vancouver Harbour, January 1986

	Concentration (µg/g, dry weight)																	
Station	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	Ti	V	Zn
- MUSCLE (continued)																			
	13	21	0.27	0.09	<0.4	0.6	47.6	37.4	0.270	2050	1.20	<0.4	<2	0.75	<0.8	64.9	0.8	<0.4	212
	19	25	0.22	<0.04	0.6	0.8	46.0	47.4	0.320	1690	1.24	<0.4	<2	0.68	<0.8	35.8	1.0	<0.4	168
- HEPATOPANCREAS																			
	13	22	0.72	1.4	1.1	0.8	317.0	201	0.684	2830	4.57	<0.4	<2	0.80	<0.8	75.7	1.0	0.6	97.1
	26	23	0.47	1.6	0.9	0.7	198.0	111	0.180	3670	4.58	<0.4	<2	0.75	<0.8	38.0	1.4	0.5	54.9
	6	11	0.85	0.7	<0.4	1.0	45.3	165	0.130	9330	4.93	<0.4	<2	0.41	<0.8	130.0	0.5	1.0	41.3
	77	26	0.81	1.4	1.1	0.9	275.0	255	0.160	10500	6.15	<0.4	<2	1.56	<0.8	114.0	3.6	0.6	80.8
	89	34	0.90	1.2	1.2	0.7	414.0	324	0.140	3910	6.24	<0.4	<2	1.38	<0.8	92.3	3.5	1.1	96.1
	71	38	0.68	2.3	2.2	0.8	247.0	324	0.190	5940	6.40	<0.4	3	4.00	<0.8	66.4	3.4	1.1	140.0
- GILL																			
	172	8	1.42	0.5	1.2	0.8	172	433	0.110	6270	5.77	<0.4	<2	2.84	<0.8	125.0	5.8	0.9	140.0
	241	6	1.74	0.8	1.4	0.9	221	516	0.096	5320	8.23	<0.4	<2	2.71	<0.8	119.0	9.0	1.0	89.9
	66	8	0.42	0.5	1.0	0.7	244	146	0.095	4720	5.37	<0.4	<2	1.42	<0.8	78.6	2.3	1.0	74.2
	138	8	1.11	0.7	1.1	0.8	238	478	0.078	5360	5.29	<0.4	<2	2.35	<0.8	117.0	4.9	1.1	91.1
	168	12	1.48	0.5	1.3	1.0	245	587	0.071	6720	5.95	<0.4	<2	5.00	<0.8	127.0	6.3	1.2	120.0
	265	14	1.99	0.5	2.2	1.3	211	813	0.088	5580	7.59	<0.4	<2	6.00	<0.8	147.0	10.5	2.0	138.0
PORT MOODY (PM)																			
DUNGENESS CRAB (Cancer magister) - MUSCLE																			
	11	14	0.16	0.06	<0.4	0.4	24.2	46.1	0.521	1440	0.97	<0.4	<2	0.54	<0.8	28.9	0.8	<0.4	217
	33	23	0.50	0.06	<0.4	0.7	50.7	98.2	0.938	1630	1.98	<0.4	<2	0.61	<0.8	83.1	1.8	<0.4	257
	13	20	0.13	0.06	<0.4	0.4	57.5	50.8	0.290	1810	1.02	<0.4	<2	0.71	<0.8	33.1	0.9	<0.4	212
	8	17	0.10	0.05	<0.4	0.4	37.2	43.3	0.739	1450	0.85	<0.4	<2	0.57	<0.8	10.5	0.4	<0.4	202
	18	14	0.21	0.05	<0.4	0.4	75.1	61.0	0.120	1920	1.18	<0.4	<2	0.77	<0.8	60.7	0.9	<0.4	277

APPENDIX IIC   Tissue Trace Metal Concentrations - Raw Data - Vancouver Harbour, January 1986

Station	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	Ti	V	Zn
	Concentration (µg/g, dry weight)																		
					- HEPATOPANCREAS														
	<4	11	0.27	0.6	<0.4	0.7	37.0	127	0.120	2410	3.20	<0.4	<2	<0.08	<0.8	52.4	0.8	<0.4	52.4
	28	19	1.05	0.8	0.5	1.0	243.0	158	0.320	5090	16.00	<0.4	<2	0.64	<0.8	391.0	0.9	<0.4	79.6
	26	21	0.50	1.7	1.2	1.2	133.0	312	0.150	5350	7.43	0.7	2	1.25	<0.8	72.8	1.4	0.6	144.0
	20	18	0.95	1.7	0.5	2.2	141.0	208	0.250	4150	7.62	0.5	<2	0.85	<0.8	224.0	0.9	<0.4	94.5
	15	15	0.43	1.7	0.4	0.8	98.8	173	0.100	2650	4.27	<0.4	<2	0.62	<0.8	33.7	1.0	<0.4	119.0
					- GILL														
	403	9	4.64	0.50	1.7	3.0	249	2500	0.550	5220	10.40	<0.4	3	25.0	<0.8	144.0	15.7	3.7	191
	868	12	7.03	0.60	2.1	4.6	305	3400	0.180	4970	19.20	<0.4	3	33.0	<0.8	183.0	26.8	5.5	209
	333	12	7.67	0.70	1.6	2.7	213	2290	0.096	5700	11.20	<0.4	2	26.0	<0.8	204.0	13.4	2.7	247
	1070	16	10.50	0.80	3.1	6.2	341	5640	0.220	4390	22.90	<0.4	3	61.0	<0.8	149.0	38.0	7.9	279
	170	6	1.68	0.24	0.7	1.1	212	576	0.067	5930	5.49	<0.4	2	5.0	<0.8	129.0	6.8	0.7	187
IOCO																			
DUNGENESS CRAB (Cancer magister) - MUSCLE																			
	17	14	1.51	<0.04	<0.4	0.5	26.8	66.2	0.096	2230	1.87	<0.4	<2	0.56	<0.8	365.0	0.6	<0.4	188
	22	15	0.60	<0.04	<0.4	0.8	22.0	63.8	0.160	1690	1.34	<0.4	<2	0.63	<0.8	135.0	0.9	<0.4	232
	62	23	1.69	<0.04	<0.4	0.6	35.0	256.0	0.056	2180	3.03	<0.4	<2	0.61	<0.8	309.0	2.1	<0.4	182
	25	13	0.16	<0.04	<0.4	0.6	22.1	64.3	0.795	1310	0.97	<0.4	<2	0.58	<0.8	17.1	0.8	<0.4	156
	27	10	1.02	<0.04	<0.4	0.6	39.1	65.9	0.130	1880	1.91	<0.4	<2	0.62	<0.8	205.0	0.9	<0.4	143
					- HEPATOPANCREAS														
	14	18	0.69	1.1	<0.4	0.7	50.6	229	0.077	3570	7.20	0.6	<2	0.63	<0.9	119.0	0.9	0.5	65.8
	9	14	0.66	1.8	0.5	0.8	50.5	226	0.150	1850	5.99	0.5	<2	0.64	<0.8	135.0	0.7	0.6	86.0
	32	22	1.09	0.9	<0.4	0.9	187.0	218	0.150	3670	12.10	0.7	<2	0.76	<0.8	325.0	1.3	0.4	90.4
	31	21	0.92	1.6	0.8	1.9	56.0	218	0.140	3510	7.93	1.1	<2	0.87	<0.8	150.0	1.5	1.1	84.0
	16	20	0.57	1.0	0.8	0.9	71.9	185	0.120	2400	5.03	0.7	<2	0.70	<0.8	78.4	1.0	0.8	102.0

APPENDIX IIC   Tissue Trace Metal Concentrations - Raw Data - Vancouver Harbour, January 1986

Station	Concentration (µg/g, dry weight)																	
	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	Ti	V	Zn
- GILL																			
	563	25	9.05	1.6	6.3	6.5	301	9620	0.110	3650	12.8	<0.4	<2	66.0	<0.8	176.0	28.6	15.9	240
	1060	10	7.06	0.7	3.5	7.4	231	4440	0.320	3680	22.1	<0.4	2	38.0	<0.8	158.0	33.7	7.0	225
	1160	13	10.10	0.9	3.7	7.5	328	5490	0.320	5110	23.6	<0.4	<2	46.0	<0.8	147.0	40.5	7.9	234
	1990	15	12.10	1.1	4.9	11.5	245	6920	0.370	5630	39.2	<0.4	4	61.0	<0.8	195.0	57.8	11.3	287
	525	12	5.90	0.7	1.9	4.2	284	3540	0.200	3530	11.8	<0.4	<2	36.0	<0.8	169.0	21.6	6.2	227
SOLE																			
PACIFIC ENVIRONMENT INSTITUTE (PEI)																			
ENGLISH SOLE (Parophrys vetulus) - MUSCLE																			
	9	20	<0.08	<0.04	<0.4	0.7	0.7	21.9	0.745	1240	0.48	<0.4	<2	<0.08	<0.8	1.30	0.2	<0.4	18.8
	12	42	<0.08	<0.04	<0.4	0.6	0.7	23.5	0.789	1140	0.44	<0.4	<2	<0.08	<0.8	0.95	0.3	<0.4	18.3
	24	17	0.12	<0.04	<0.4	0.9	0.9	49.2	0.361	1470	0.82	<0.4	<2	<0.08	<0.8	2.92	1.2	<0.4	18.3
	22	18	0.09	<0.04	<0.4	0.8	0.9	47.8	0.400	1230	0.74	<0.4	<2	<0.08	<0.8	1.09	1.1	<0.4	18.0
	22	21	0.11	<0.04	<0.4	0.8	1.1	49.4	0.310	1200	0.75	<0.4	3	<0.08	<0.8	2.26	1.1	<0.4	15.8
	61	46	0.31	<0.04	<0.4	0.9	1.4	113.0	0.420	1220	1.61	<0.4	2	<0.08	<0.8	3.56	2.4	<0.4	20.2
- LIVER																			
	9	13	<0.08	1.0	<0.4	1.1	56.4	737	0.410	1340	6.45	<0.4	2	0.20	<0.8	3.59	0.4	1.1	134
	12	35	<0.08	0.4	<0.4	1.1	96.8	468	0.360	1090	6.65	<0.4	<2	0.46	<0.8	2.51	0.8	1.1	181
	30	28	0.10	2.5	2.2	0.5	35.3	1070	0.365	616	3.60	<0.4	3	0.54	<0.8	2.32	1.4	3.1	121
	29	21	0.12	0.8	<0.4	0.8	66.5	714	0.310	1010	6.03	<0.4	<2	0.21	<0.8	1.86	1.4	1.3	185
	22	32	<0.08	2.8	0.7	0.5	40.4	1950	0.320	502	2.36	<0.4	<2	0.92	<0.8	1.99	1.0	3.5	106
	14	53	<0.08	1.5	<0.4	0.7	41.5	576	0.370	952	3.99	<0.4	<2	1.86	<0.8	2.16	0.8	1.1	125
- GILL																			
	372	<4	2.95	0.08	<0.4	3.1	6.6	776	0.781	1430	31.90	<0.4	3	0.09	<0.8	242	10.3	1.7	66.9
	96	<4	1.23	<0.04	<0.4	1.5	4.1	261	0.351	1210	14.20	<0.4	3	<0.08	<0.8	193	2.4	1.5	64.4
	920	<4	5.72	0.09	<0.4	3.6	14.7	1790	0.500	1880	33.60	<0.4	6	4.00	<0.8	266	23.9	3.7	72.3
	639	4	4.23	0.11	<0.4	2.6	11.4	1290	0.360	1570	26.50	<0.4	4	0.27	<0.8	215	17.2	2.7	67.3
	99	<4	3.64	0.11	<0.4	1.5	3.3	325	0.420	1240	14.60	<0.4	3	<0.08	<0.8	318	2.3	1.2	69.0
	186	8	2.27	0.07	<0.4	2.3	3.9	507	0.120	1340	22.10	<0.4	3	<0.08	<0.8	314	5.6	1.7	78.9

APPENDIX IIC Tissue Trace Metal Concentrations - Raw Data - Vancouver Harbour, January 1986

Station	Concentration (µg/g, dry weight)																	
	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	Ti	V	Zn
CENTRE (CT)																			
ENGLISH SOLE (Parophrys vetulus) - MUSCLE																			
	17	37	<0.08	1.5	2.1	1.7	16.5	603.0	0.090	931	7.04	<0.4	<2	9.00	<0.8	2.87	0.7	3.8	136.0
	5	92	<0.08	<0.04	<0.4	0.9	7.8	12.8	0.350	1190	0.43	<0.4	<2	0.12	<0.8	4.75	<0.2	<0.4	22.0
	4	57	<0.08	<0.04	<0.4	0.5	0.4	17.6	0.160	1090	0.34	<0.4	<2	<0.08	<0.8	1.82	<0.2	<0.4	18.3
	5	64	<0.08	<0.04	<0.4	0.7	0.8	18.9	0.310	1250	0.46	<0.4	<2	<0.08	<0.8	3.72	<0.2	<0.4	19.1
	5	24	0.17	<0.04	<0.4	0.7	0.6	14.4	0.290	1250	1.33	<0.4	<2	<0.08	<0.8	30.8	<0.2	<0.4	23.2
	8	46	<0.08	<0.04	<0.4	0.4	1.2	27.1	0.270	1300	0.58	<0.4	<2	<0.08	<0.8	3.26	0.3	<0.4	20.4
- LIVER																			
	6	47	<0.08	<0.04	<0.4	<0.4	3.9	22.6	0.250	1240	0.38	<0.4	<2	<0.08	<0.8	3.57	<0.2	<0.4	22.7
	7	18	<0.08	0.6	<0.4	0.8	15.3	164.0	0.160	953	6.30	<0.4	<2	7.00	<0.8	2.43	0.5	1.7	143.0
	14	20	<0.09	1.1	0.7	2.4	36.0	489.0	-	1000	8.24	<0.4	<2	2.81	<0.9	3.91	0.7	0.6	279.0
	20	10	0.10	0.8	0.7	0.9	26.9	182.0	0.210	1040	6.68	<0.4	<2	6.00	<0.8	2.52	1.1	1.1	207.0
	8	9	<0.08	2.5	0.5	0.5	38.4	150.0	0.370	764	4.06	<0.4	<2	1.88	<0.8	1.74	0.4	0.4	179.0
	8	53	<0.08	0.8	1.0	0.7	7.2	673.0	0.250	919	4.25	<0.4	<2	1.08	<0.8	1.81	0.5	0.8	198.0
- GILL																			
	81	7	2.07	0.08	<0.4	1.5	4.8	325.0	0.090	1140	9.99	<0.4	2	4.00	<0.8	328	2.2	1.6	82.9
	84	5	1.72	0.07	<0.4	1.3	4.7	282.0	0.160	1240	9.09	<0.4	<2	5.00	<0.8	315	2.3	1.2	65.9
	53	4	2.58	0.08	<0.4	1.1	2.6	200.0	0.170	1250	18.7	<0.4	<2	<0.08	<0.8	289	1.2	0.5	64.7
	38	<4	1.46	0.10	<0.4	1.3	2.6	176.0	0.150	1190	7.44	<0.4	<2	0.14	<0.8	359	0.6	1.0	58.2
	41	<4	1.08	0.11	<0.4	1.4	2.7	183.0	0.130	1240	8.44	<0.4	<2	0.08	<0.8	281	0.8	0.5	81.6
	20	<4	1.30	0.07	<0.4	1.2	2.6	187.0	0.150	1200	10.9	<0.4	<2	<0.08	<0.8	285	0.3	0.8	72.8
PORT MOODY (PM) - TRAWL #1																			
ENGLISH SOLE (Parophrys vetulus) - MUSCLE																			
	22	36	0.16	<0.04	<0.4	0.8	1.5	45.9	0.420	1190	0.76	<0.4	<2	<0.08	<0.8	1.82	1.5	<0.4	19.9
	12	85	<0.08	0.06	<0.4	0.5	1.4	30.8	0.733	1340	0.52	<0.4	35	<0.08	<0.8	1.79	0.4	<0.4	22.8
	12	97	<0.08	<0.04	<0.4	0.5	1.5	25.7	0.548	1180	0.47	<0.4	<2	<0.08	<0.8	3.83	0.3	<0.4	23.0

APPENDIX IIC Tissue Trace Metal Concentrations - Raw Data - Vancouver Harbour, January 1986

	Concentration (µg/g, dry weight)																		
Station	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	Ti	V	Zn
					- MUSCLE (continued)														
	19	68	0.42	<0.04	<0.4	0.8	2.0	43.6	0.340	1460	0.68	<0.4	<2	0.10	<0.8	2.13	1.1	<0.4	19.3
	25	27	0.13	<0.04	<0.4	0.8	2.7	76.2	0.140	1190	0.92	<0.4	<2	<0.08	<0.8	3.48	1.4	<0.4	21.0
	22	55	0.14	<0.04	<0.4	4.6	2.5	158.0	0.350	1360	1.53	<0.4	14	0.09	<0.8	1.99	1.5	<0.4	19.9
					- LIVER														
	31	19	0.16	0.9	1.9	1.2	12.3	842	0.659	1050	6.51	<0.4	<2	0.91	<0.8	2.82	1.4	2.6	103.0
	12	15	<0.08	1.5	1.2	0.9	17.5	205	0.140	1120	5.79	<0.4	<2	7.00	<0.8	2.06	0.7	2.1	133.0
	35	21	<0.08	8.3	0.6	0.6	16.1	652	1.060	795	3.37	<0.4	<2	8.00	<0.8	3.64	0.7	8.3	116.0
	17	18	<0.08	1.4	0.4	0.9	39.0	66.3	0.080	994	5.37	<0.4	<2	7.00	<0.8	4.63	0.6	2.8	122.0
	24	9	0.15	0.7	0.6	1.0	8.7	1140	0.080	1020	7.65	<0.4	<2	0.64	<0.8	4.06	0.8	2.5	102.0
	15	17	<0.08	1.5	<0.4	0.7	30.1	73	0.120	980	6.40	<0.4	<2	6.00	<0.8	2.16	1.1	1.8	104.0
					- GILL														
	62	<4	1.32	0.05	<0.4	1.1	3.0	216	0.120	989	8.83	<0.4	<2	0.15	<0.8	208	1.8	0.9	54.7
	88	<4	1.82	0.09	<0.4	1.6	4.7	238	0.140	1330	10.40	<0.4	<2	5.00	<0.8	334	2.1	1.6	64.9
	97	<4	2.21	0.10	<0.4	1.9	4.8	244	0.260	1370	10.60	<0.4	5	5.00	<0.8	372	2.6	1.9	69.0
	193	<4	2.30	0.11	<0.4	1.7	8.3	350	0.120	1400	9.73	<0.4	<2	5.00	<0.8	287	6.7	1.6	67.4
	73	<4	1.76	0.11	<0.4	1.3	3.5	283	0.140	1140	16.80	<0.4	<2	0.11	<0.8	266	2.1	1.2	69.1
	68	5	1.57	0.12	<0.4	1.4	4.7	163	0.120	1360	7.45	<0.4	<2	4.00	<0.8	303	1.8	1.2	64.6
PORT MOODY (PM) - TRAWL #2																			
ENGLISH SOLE (Parophrys vetulus) - MUSCLE																			
	11	41	<0.08	<0.04	<0.4	0.6	1.5	32.4	0.420	1230	0.54	<0.4	<2	<0.08	<0.8	3.74	0.8	<0.4	25.2
	9	26	<0.08	<0.04	<0.4	0.6	1.3	20.1	0.190	1170	0.38	<0.4	<2	<0.08	<0.8	1.32	0.6	<0.4	23.8
	10	40	<0.08	<0.04	<0.4	0.5	0.8	23.7	0.310	1260	0.46	<0.4	<2	<0.08	<0.8	1.39	0.7	<0.4	19.1
	6	113	<0.08	<0.04	<0.4	0.5	0.7	15.7	0.390	1340	0.45	<0.4	<2	<0.08	<0.8	2.26	<0.2	<0.4	22.4
	6	30	<0.08	<0.04	<0.4	0.4	0.9	17.8	0.360	1240	0.41	<0.4	<2	<0.08	<0.8	1.72	0.2	<0.4	20.6
	6	29	0.20	<0.04	<0.4	0.5	0.8	21.6	0.360	1320	0.73	<0.4	<2	<0.08	<0.8	21.2	<0.2	<0.4	21.3

APPENDIX IIC Tissue Trace Metal Concentrations - Raw Data - Vancouver Harbour, January 1986

	Concentration (µg/g, dry weight)																		
Station	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	Ti	V	Zn
					- LIVER														
	31	13	0.08	2.8	6.8	0.7	5.7	304	0.190	1030	4.60	<0.4	<2	0.36	<0.8	2.73	1.0	5.3	99.4
	11	8	<0.08	0.4	1.0	1.5	3.4	370	0.180	965	5.44	<0.4	3	0.24	<0.8	1.56	0.6	1.9	97.1
	20	9	<0.08	0.6	0.8	0.5	6.4	486	0.180	629	3.03	<0.4	<2	0.21	<0.8	2.15	0.7	2.3	84.4
	25	22	<0.08	0.9	0.6	0.7	4.9	737	0.220	823	4.12	<0.4	<2	0.71	<0.8	2.25	0.7	3.9	104.0
	12	9	<0.09	0.5	0.5	0.8	6.0	380	0.230	840	3.82	<0.4	<2	0.68	<0.9	2.02	0.6	1.9	137.0
	26	13	<0.08	2.3	2.4	0.7	3.8	1330	0.170	724	3.07	<0.4	<2	0.72	<0.8	2.63	0.6	4.8	79.4
					- GILL														
	34	<4	2.73	0.25	<0.4	1.6	1.5	163	0.270	1220	7.29	<0.4	<2	0.44	<0.8	503	0.4	1.6	78.0
	145	<4	1.66	0.07	<0.4	1.6	2.6	386	0.210	1190	11.80	<0.4	<2	0.34	<0.8	270	4.2	1.3	72.5
	70	<4	1.39	0.08	<0.4	1.3	2.5	265	0.210	1100	10.30	<0.4	<2	0.18	<0.8	295	2.0	0.9	68.1
	116	<4	2.29	0.18	<0.4	1.7	2.4	359	0.240	1280	10.20	<0.4	<2	0.40	<0.8	274	3.7	1.3	73.4
	83	7	1.63	0.50	0.7	2.1	2.8	273	0.230	1050	8.86	<0.4	<2	8.00	<0.8	278	2.4	2.4	70.4
	89	<4	3.45	0.06	<0.4	1.5	1.9	277	0.210	1280	9.57	<0.4	<2	4.00	<0.8	395	2.3	1.3	72.1
OTHER FISH SPECIES																			
CENTRE (CT)																			
SHINNER PERCH (Cymatogaster aggregata) - MUSCLE																			
	5	5	<0.08	<0.04	<0.4	0.5	2.2	15.3	0.290	1510	1.41	<0.4	<2	<0.08	<0.8	7.80	<0.2	<0.4	19.3
	14	7	0.10	<0.04	0.4	1.0	3.9	23.3	0.450	1500	1.70	0.5	2	<0.08	<0.8	7.24	0.2	0.6	26.4
	6	4	<0.08	<0.04	<0.4	0.6	1.5	27.1	0.140	1370	2.09	<0.4	<2	<0.08	<0.8	13.90	<0.2	<0.4	21.9

APPENDIX III

TISSUE TRACE METAL CONCENTRATIONS

DESCRIPTIVE STATISTICS

VANCOUVER HARBOUR

A. MAY 1985

B. OCTOBER 1985

C. JANUARY 1986

APPENDIX IIIA Tissue Trace Metal Concentrations - Descriptive Statistics - Vancouver Harbour, May 1985.

Station	Concentration (µg/g dry weight)													
	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
PACIFIC ENVIRONMENT INSTITUTE (PEI)														
PINK SHRIMP (Pandalus borealis) - MUSCLE														
MEAN(28)	11.1	41.8	0.15	0.24	0.5	14.2	29.8	-	1499	1.47	0.4	2.0	0.09	46.3
S.D.	10.8	6.3	0.12	0.33	0.1	2.7	20.2	-	92	0.26	0.1	0	0.03	2.4
C.V.(%)	97	15	79	138	22	19	68	-	6	18	13	0	36	5
MAX.	45.0	54.0	0.54	1.50	0.8	24.3	82.0	-	1780	2.25	0.6	<2.0	0.20	51.0
MIN.	<4.0	31.0	<0.08	0.07	<0.4	11.8	8.2	-	1370	0.97	<0.4	<2.0	<0.08	42.0
- HEPATOPANCREAS														
MEAN(12)	43.2	29.5	0.43	9.54	0.6	1264.9	295.8	-	666	9.89	1.0	2.0	0.29	91.4
S.D.	72.6	5.3	0.33	1.60	0.2	239.5	159.1	-	139	2.74	0.3	0	0.35	11.3
C.V.(%)	168	18	78	17	40	19	54	-	21	28	35	0	120	12
MAX.	267.0	38.0	1.38	12.00	1.0	1760.0	770.0	-	885	17.20	1.6	<2.0	1.34	110.0
MIN.	<4.0	20.0	0.18	6.90	<0.4	919.0	167.0	-	399	6.01	<0.4	<2.0	<0.08	74.7
COONSTRIPE SHRIMP (Pandalus danae) - MUSCLE														
MEAN(2)	17.0	19.5	0.44	0.73	0.5	11.5	36.2	-	1385	1.50	0.4	2.0	0.09	47.2
S.D.	2.8	6.4	0.44	0.95	0.1	1.3	1.1	-	78	0.01	0	0	0.01	2.7
C.V.(%)	17	33	100	130	16	12	3	-	6	1	0	0	8	6
MAX.	19.0	24.0	0.75	1.40	0.5	12.4	37.0	-	1440	1.51	<0.4	<2.0	0.09	49.1
MIN.	15.0	15.0	0.13	0.06	0.4	10.5	35.4	-	1330	1.49	<0.4	<2.0	<0.08	45.3
PRAWN (Pandalus platyceros) - MUSCLE														
MEAN(3)	10.3	24.7	0.17	0.12	0.4	15.4	31.9	-	1460	1.33	0.4	2.0	0.10	45.8
S.D.	7.1	9.3	0.13	0.06	0.06	1.3	15.3	-	115	0.27	0	0	0.03	1.8
C.V.(%)	69	38	79	47	13	9	48	-	8	20	0	0	30	4
MAX.	18.0	35.0	0.32	0.18	0.5	16.8	48.5	-	1580	1.54	<0.4	<2.0	0.13	47.9
MIN.	<4.0	17.0	<0.08	0.08	<0.4	14.2	15.3	-	1350	1.03	<0.4	<2.0	<0.08	44.5

APPENDIX IIIA Tissue Trace Metal Concentrations - Descriptive Statistics - Vancouver Harbour, May 1985.

Station	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
						Concentration (µg/g dry weight)								
- HEPATOPANCREAS														
MEAN(2)	208.0	31.0	2.05	3.60	1.7	1125	1294	-	1125	18.7	0.7	5.0	0.48	130.0
S.D.	271.5	12.7	2.48	0.42	1.8	21	1041	-	757	11.7	0.4	0	0.45	41.0
C.V.(%)	131	41	121	12	108	2	80	-	67	63	61	0	94	32
MAX.	400.0	40.0	3.80	3.90	3.0	1140	2030	-	1660	27.0	<1.0	5.0	0.80	159.0
MIN.	16.0	22.0	0.29	3.30	0.4	1110	558	-	590	10.4	<0.4	<5.0	0.16	101.0
COAL HARBOUR (CH)														
HUMPBACK SHRIMP (Pandalus hypsinotus) - MUSCLE														
MEAN(12)	36	26	0.61	0.27	0.7	16.2	82.1	0.20	1600	1.47	0.4	2	1.07	57.5
S.D.	20	5	1.31	0.05	0.2	4.2	43.3	0.06	160	0.37	0	0	0.19	9.5
C.V.(%)	55	19	2.13	19	23	26	53	30	10	25	0	0	18	16
MAX.	90	35	4.56	0.34	1.1	21.5	189.0	0.28	1970	1.99	<0.4	<2	1.57	66.2
MIN.	9	17	<0.08	0.18	<0.4	8.6	25.5	0.10	1430	0.69	<0.4	<2	0.93	37.3
- HEPATOPANCREAS														
MEAN(6)	45	26	0.37	4.77	0.7	528.7	321.2	0.12	616	8.53	1.7	2	0.98	96.6
S.D.	38	4	0.17	1.34	0.1	118.8	83.0	0.02	61	0.79	0.3	0	0.43	14.2
C.V.(%)	85	16	47	28	22	22	26	14	10	9	20	0	44	15
MAX.	120	33	0.65	6.50	0.9	662.0	417.0	0.13	705	9.76	2.2	2	1.70	121.0
MIN.	15	20	0.21	3.00	0.5	324.0	183.0	0.09	530	7.47	1.2	<2	0.62	82.4
COONSTRIPE SHRIMP (Pandalus danae) - MUSCLE														
MEAN(6)	27	22	0.17	0.28	0.6	17.3	55.8	0.45	1550	1.59	0.4	2	1.02	57.8
S.D.	14	2	0.04	0.03	0.1	2.3	18.1	0.24	68	0.38	0	0	0.06	4.2
C.V.(%)	52	9	24	10	14	13	32	54	4	24	0	0	6	7
MAX.	54	24	0.23	0.33	0.7	19.8	88.0	0.81	1640	2.21	<0.4	<2	1.14	62.7
MIN.	14	19	0.13	0.25	0.5	14.4	35.0	0.15	1460	1.20	<0.4	<2	0.98	51.4

APPENDIX IIIA Tissue Trace Metal Concentrations - Descriptive Statistics - Vancouver Harbour, May 1985.

Station	Concentration (µg/g dry weight)												
	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
- HEPATOPANCREAS													
MEAN(6)	71	34	0.67	7.93	0.9	1301.7	807.2	0.27	809	12.66	2.5	2	1.51	122.0
S.D.	93	7	0.55	3.31	0.1	262.6	305.5	0.09	185	3.27	0.4	0	0.21	17.5
C.V.(%)	131	21	82	42	13	20	38	32	23	26	15	0	14	14
MAX.	252	41	1.72	14.40	1.1	1710.0	1350.0	0.43	1050	17.50	3.0	<2	1.90	142.0
MIN.	9	24	0.30	5.60	0.8	1090.0	535.0	0.19	570	8.66	2.0	<2	1.33	102.0
CRANGON SHRIMP (*Crangon communis*) - MUSCLE													
MEAN(3)	102	11	0.72	0.28	0.9	33.6	261.3	0.10	1420	3.64	0.5	2	1.24	82.9
S.D.	26	1	0.15	0.02	0.3	6.2	101.0	0.05	36	0.72	0.2	0	0.22	9.9
C.V.(%)	25	9	21	8	29	18	39	48	3	20	35	0	18	12
MAX.	124	12	0.86	0.31	1.1	40.6	364.0	0.16	1460	4.18	0.7	<2	1.49	94.4
MIN.	74	10	0.56	0.27	0.6	28.7	162.0	0.07	1390	2.82	[illegible].4	<2	1.10	77.0
PINK SHRIMP (*Pandalus borealis*) - MUSCLE													
MEAN(6)	31	25	0.26	0.25	0.6	11.8	68.2	0.31	1520	1.63	0.4	2	1.04	51.3
S.D.	13	4	0.10	0.01	0.2	2.4	24.2	0.20	73	0.37	0	0	0.09	2.7
C.V.(%)	41	15	40	5	38	20	36	64	5	22	0	0	9	5
MAX.	53	32	0.38	0.26	1.0	14.6	111.0	0.69	1640	2.07	<0.4	<2	1.21	56.0
MIN.	14	21	0.12	0.23	0.4	8.6	38.7	0.15	1420	1.04	<0.4	<2	0.96	48.8
- HEPATOPANCREAS													
MEAN(6)	127	30	0.93	4.57	1.0	824.5	390.7	0.29	835.8	12.12	1.9	2	1.03	99.7
S.D.	155	8	0.78	1.17	0.3	272.9	247.1	0.08	219.7	4.26	0.8	0	0.48	10.0
C.V.	122	27	85	26	27	33	63	29	26	35	42	0	46	10
MAX.	329	39	2.10	6.50	1.4	1280.0	736.0	0.41	1180.0	19.00	3.0	2	1.70	111.0
MIN.	25	19	0.30	2.90	0.6	568.0	211.0	0.18	610.0	7.60	1.1	<2	0.50	89.4

APPENDIX IIIA Tissue Trace Metal Concentrations - Descriptive Statistics - Vancouver Harbour, May 1985.

Station	Concentration (µg/g dry weight) Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
STERLING (ST)														
COONSTRIPE SHRIMP (Pandalus danae) - MUSCLE														
MEAN(11)	8	22	0.14	0.05	0.5	17.7	20.5	0.21	1641	1.25	0.41	2	0.09	55.2
S.D.	7	4	0.05	0.01	0.1	2.3	9.6	0.08	73	0.20	0.03	0	0.02	2.6
C.V.(%)	84	19	39	17	20	13	47	38	4	16	8	0	18	5
MAX.	27	29	0.27	0.06	0.7	22.1	46.6	0.37	1730	1.59	0.5	<2	0.10	58.4
MIN.	<4	16	<0.08	<0.04	<0.4	13.3	10.1	0.12	1520	0.95	<0.4	<2	<0.08	51.2
- HEPATOPANCREAS														
MEAN(2)	17	40	0.45	10.50	0.7	1190.0	717.0	0.18	1030	12.30	2.3	2	0.35	117.5
S.D.	15	8	0.07	1.70	0	240.4	174.0	0.00	141	0.71	0.1	0	0.07	4.9
C.V.(%)	90	20	16	16	0	20	24	4	14	6	4	0	20	4
MAX.	27	45	0.50	11.70	0.7	1360.0	840.0	0.18	1130	12.80	2.4	<2	0.40	121.0
MIN.	6	34	0.40	9.30	0.7	1020.0	594.0	0.17	930	11.80	2.2	<2	0.30	114.0
CHEVRON (CV)														
COONSTRIPE SHRIMP (Pandalus danae) - MUSCLE														
MEAN(12)	4	23	0.11	0.17	1.6	17.3	14.7	0.18	1456	1.05	0.4	2	1.20	43.9
S.D.	1	4	0.06	0.01	0.5	2.0	5.0	0.07	37	0.10	0.1	0.3	0.10	17.4
C.V.(%)	27	19	50	8	34	12	34	36	3	9	27	15	8	40
MAX.	<8	30	0.25	0.18	2.3	21.3	25.9	0.35	1520	1.21	<0.8	<3	1.34	64.2
MIN.	<4	17	<0.08	0.14	0.9	14.4	8.2	0.11	1400	0.90	<0.4	<2	1.00	<0.3
- HEPATOPANCREAS														
MEAN(6)	15	67	0.43	10.65	3.0	793.3	316.3	0.06	807	14.63	1.8	3	1.12	84.7
S.D.	19	8	0.16	2.56	1.8	94.2	74.8	0.01	115	1.62	0.3	0.4	0.13	15.6
C.V.(%)	125	11	38	24	62	12	24	17	14	11	16	14	12	18
MAX.	53	76	0.70	14.90	6.1	948.0	440.0	0.08	1000	16.50	2.3	<3	1.30	104.0
MIN.	<4	58	0.25	7.90	1.1	687.0	235.0	0.04	670	12.10	1.4	<2	1.00	58.3

APPENDIX IIIA Tissue Trace Metal Concentrations - Descriptive Statistics - Vancouver Harbour, May 1985.

Station	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
	Concentration (µg/g dry weight)													
CATES PARK														
COONSTRIPE SHRIMP (Pandalus danae) - MUSCLE														
MEAN(6)	8	18	0.17	0.20	0.5	19.3	40	0.06	1747	1.5	0.4	2	1.43	56.1
S.D.	3	4	0.10	0.04	0.1	2.9	13	0.04	68	0.2	0	0	0.11	2.5
C.V.(%)	33	24	55	21	17	15	32	60	4	11	0	0	7	4
MAX.	12	21	0.35	0.28	0.6	22.4	63	0.13	1840	1.7	<0.4	<2	1.57	60.9
MIN.	<4	10	0.08	0.18	<0.4	15.3	24	0.02	1660	1.2	<0.4	<2	1.29	53.9
- HEPATOPANCREAS														
MEAN(2)	12	29	0.65	6.05	0.8	959.5	720	-	1445	14.8	1.9	3	1.50	115.5
S.D.	7	6	0.07	0.07	0.1	113.8	151	-	304	0.8	0.3	0	0.14	13.4
C.V.(%)	59	22	11	1	9	12	21	-	21	5	15	0	9	12
MAX.	17	33	0.70	6.10	0.8	1040.0	827	-	1660	15.3	2.1	<3	1.60	125.0
MIN.	<7	24	0.60	6.00	<0.7	879.0	613	-	1230	14.2	1.7	<3	1.40	106.0
BOULDER ROCK														
HUMPBACK SHRIMP (Pandalus hypsinotus) - MUSCLE														
MEAN(8)	18.9	19.0	0.2	0.05	0.5	16.5	36.7	-	1545.0	1.4	0.4	2.1	0.13	55.0
S.D.	14.2	5.8	0.1	0.01	0.1	2.9	21.0	-	194.6	0.3	0.04	0.4	0.05	4.8
C.V.(%)	75	31	58	16	15	17	57	-	13	21	9	17	38	9
MAX.	37.0	33.0	0.49	0.06	0.6	23.1	68.3	-	1930.0	1.8	<0.5	3.0	<0.20	63.9
MIN.	<4.0	16.0	0.08	<0.04	<0.4	14.4	9.9	-	1340.0	1.0	<0.4	<2.0	<0.09	48.9
- HEPATOPANCREAS														
MEAN(2)	35.0	27.0	0.4	2.2	0.6	1075.5	310.0	-	735.0	12.2	0.8	7.0	2.15	117.5
S.D.	14.1	8.5	0.1	0.4	0.1	133.6	8.5	-	63.6	0.1	0.1	3.0	2.62	0.3
C.V.(%)	40	31	35	19	13	12	3	-	9	1	18	43	122	0
MAX.	45.0	33.0	0.5	2.5	0.6	1170.0	316.0	-	780.0	12.3	0.9	10.0	4.0	118.0
MIN.	25.0	21.0	0.3	1.9	0.5	981.0	304.0	-	690.0	12.1	0.7	4.0	<0.3	117.0

APPENDIX IIIA Tissue Trace Metal Concentrations - Descriptive Statistics - Vancouver Harbour, May 1985.

	Concentration (µg/g dry weight)													
Station	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
COONSTRIPE SHRIMP (Pandalus danae) - MUSCLE														
MEAN(6)	28.5	21.8	0.2	0.11	0.7	22.7	58.5	-	1585.0	1.7	0.4	2.3	1.1	55.6
S.D.	12.1	7.9	0.1	0.12	0.1	3.5	22.7	-	52.4	0.3	0	0.5	1.5	2.4
C.V.(%)	43	36	30	109	22	15	39	-	3	16	0	22	131	4
MAX.	48.0	33.0	0.3	0.35	0.9	27.2	99.1	-	1680.0	2.0	<0.4	3.0	3.0	58.9
MIN.	17.0	16.0	0.1	0.05	0.5	18.8	37.9	-	1530.0	1.4	<0.4	<2.0	0.13	53.0
- HEPATOPANCREAS														
MEAN(2)	31.5	41.5	0.4	2.9	0.9	1212.0	641.5	-	1080.0	14.6	1.4	5.5	2.1	132.5
S.D.	16.3	12.0	0.1	0.6	0.2	534.6	109.6	-	42.4	0.4	0.5	0.7	1.3	16.3
C.V.(%)	52	29	35	20	25	44	17	-	4	3	37	13	66	12
MAX.	43.0	50.0	0.5	3.3	<1.0	1590.0	719.0	-	1110.0	14.9	1.7	6.0	3.0	144.0
MIN.	20.0	33.0	0.3	2.5	0.7	834.0	564.0	-	1050.0	14.3	<1.0	5.0	1.1	121.0
PORT MOODY (PM)														
COONSTRIPE SHRIMP (Pandalus danae) - MUSCLE														
MEAN(6)	21	21	0.22	0.21	0.6	20.8	35.9	0.14	1742	1.29	0.4	2	1.41	61.4
S.D.	15	4	0.09	0.02	0.1	2.0	16.0	0.08	114	0.14	0	0	0.08	3.0
C.V.(%)	75	17	41	10	18	10	45	60	7	10	0	0	6	5
MAX.	47	27	0.36	0.24	0.7	24.1	55.2	0.25	1920	1.44	<0.4	<2	1.51	65.1
MIN.	6	17	0.12	0.19	0.4	18.5	17.6	0.06	1650	1.08	<0.4	<2	1.27	57.7
- HEPATOPANCREAS														
MEAN(3)	50	23	0.93	2.07	1.0	1350.0	630.7	0.05	833	12.47	2.3	5	0.70	123.0
S.D.	10	15	0.38	0.49	0	95.4	238.4	0	136	1.46	0.6	0	0.35	6.6
C.V.(%)	20	65	41	24	0	7	38	0	16	12	25	0	49	5
MAX.	60	40	1.20	2.40	1.0	1410.0	906.0	0.05	990	14.10	3.0	<5	1.10	130.0
MIN.	40	10	0.50	1.50	<1.0	1240.0	493.0	0.05	750	11.30	2.0	<5	0.50	117.0

APPENDIX IIIA   Tissue Trace Metal Concentrations - Descriptive Statistics - Vancouver Harbour, May 1985.

Station	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
	Concentration (µg/g dry weight)													
CRAB														
PACIFIC ENVIRONMENT INSTITUTE (PEI)														
DUNGENESS CRAB (Cancer magister) - MUSCLE														
MEAN(3)	26.7	64.0	0.35	0.09	0.6	35.8	96.9	-	1633	2.77	0.4	2.0	0.12	207.0
S.D.	8.3	31.0	0.14	0.03	0.3	9.4	22.9	-	91	1.39	0	0	0.04	14.7
C.V.(%)	31	48	40	29	40	26	24	-	6	50	0	0	33	7
MAX.	36.0	95.0	0.51	0.12	0.9	45.9	121.0	-	1700	4.31	<0.4	<2.0	0.16	216.0
MIN.	20.0	33.0	0.25	0.07	<0.4	27.3	75.5	-	1530	1.61	<0.4	<2.0	0.08	190.0
- HEPATOPANCREAS														
MEAN(2)	27.5	25.5	0.78	3.13	0.9	188.5	256.0	-	1721	9.61	0.7	2.0	0.35	147.5
S.D.	2.1	6.4	0.28	4.20	0.4	238.4	157.0	-	1569	2.26	0.4	0	0.13	29.0
C.V.(%)	8	25	36	134	47	126	61	-	91	23	61	0	39	20
MAX.	29.0	30.0	0.97	6.10	1.2	357.0	367.0	-	2830	11.20	1.0	<2.0	0.44	168.0
MIN.	26.0	21.0	0.58	0.16	0.6	19.9	145.0	-	611	8.01	<0.4	<2.0	0.25	127.0
- GILL														
MEAN(3)	1116.0	29.3	10.61	1.22	4.5	234	3767	-	3777	35.87	0.4	5.3	1.89	354.3
S.D.	1286.5	5.0	8.78	0.41	4.9	69	4107	-	1768	32.70	0	4.0	2.74	137.2
C.V.(%)	115	17	83	33	110	29	109	-	47	91	0	76	145	39
MAX.	2590.0	34.0	20.60	1.50	10.1	308	8490	-	5790	73.50	<0.4	10.0	5.05	437.0
MIN.	219.0	29.3	4.14	1.22	1.2	234	1040	-	2480	14.40	<0.4	3.0	0.09	354.3
BURRARD YARROWS														
DUNGENESS CRAB (Cancer magister) - MUSCLE														
VALUE	9	19	0.17	<0.04	0.4	32.8	46.1	0.11	1490	1.13	<0.4	<2	0.1	224.0
- HEPATOPANCREAS														
VALUE	<4	11	0.26	0.08	0.5	8.7	83.3	<0.02	362	6.16	<0.4	<2	0.68	175.0

APPENDIX IIIA Tissue Trace Metal Concentrations - Descriptive Statistics - Vancouver Harbour, May 1985.

Station	Concentration (µg/g dry weight) Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
- GILL														
VALUE	121	18	3.56	0.5	1.2	233.0	853.0	0.06	4140	6.47	1.3	<2	8.0	187.0
COAL HARBOUR (CH)														
TANNER CRAB (Chionocetes bairdi) - MUSCLE														
VALUE	33	28	0.24	0.23	0.8	18.7	79.5	0.47	2310	1.57	<0.4	<2	1.50	114.0
- HEPATOPANCREAS														
VALUE	113	38	0.62	29.40	0.7	852.0	1230.0	0.66	1920	7.65	4.8	<2	1.47	100.0
- GILL														
VALUE	6790	45	17.50	10.00	12.2	74.5	15100	0.73	9480	149.00	46.1	13	37.00	69.7
DUNGENESS CRAB (Cancer magister) - MUSCLE														
MEAN(4)	18	20	0.23	0.34	0.8	33.4	80.2	0.25	1653	1.59	0.7	2	1.58	184.0
S.D.	11	8	0.14	0.12	0.1	16.7	59.4	0.09	436	0.45	0.1	0	0.34	8.0
C.V.(%)	64	40	62	35	15	50	74	37	26	28	14	0	22	4
MAX.	33	24	0.42	0.51	1.0	57.5	163.0	0.36	2250	2.13	0.8	<2	2.03	196.0
MIN.	8	8	0.09	0.26	0.7	19.9	31.3	0.17	1250	1.21	<0.4	<2	1.26	179.0
- HEPATOPANCREAS														
MEAN(4)	18	25	0.94	3.20	1.4	149.4	253.3	0.25	3303	8.16	2.0	3	2.10	108.9
S.D.	2	9	0.38	1.28	0.4	169.7	85.6	0.09	2773	1.04	1.0	1.4	0.71	25.1
C.V.(%)	12	36	41	40	32	114	34	34	84	13	52	47	34	23
MAX.	20	33	1.48	4.40	2.0	394.0	334.0	0.36	7410	9.27	3.3	5	3.06	135.0
MIN.	15	13	0.61	2.00	1.0	18.3	144.0	0.16	1560	6.77	0.9	<2	1.34	82.2
- GILL														
MEAN(4)	285	17	3.17	0.97	1.4	106.1	1058.0	0.17	4065	11.26	3.2	2	4.84	180.3
S.D.	73	8	0.33	0.35	0.2	21.8	245.8	0.06	743	2.40	0.9	0	2.72	43.8
C.V.(%)	25	46	10	36	17	21	23	38	18	21	29	0	56	24

APPENDIX IIIA Tissue Trace Metal Concentrations - Descriptive Statistics - Vancouver Harbour, May 1985.

Station	Concentration (µg/g dry weight) Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
- GILL (continued)														
MAX.	364	29	3.55	1.29	1.6	134.0	1420.0	0.24	4790	14.30	4.4	<2	8.00	222.0
MIN.	211	12	2.81	0.47	1.1	81.3	876.0	0.10	3050	8.43	2.2	<2	1.83	134.0
STERLING (ST)														
DUNGENESS CRAB (Cancer magister) - MUSCLE														
MEAN(2)	7	19	0.12	0.04	0.5	38.3	29.3	0.21	1825	1.02	0.4	2	0.15	163.0
S.D.	0	4	0.03	0	0.1	14.3	2.5	0.35	559	0.06	0	0	0.08	2.8
C.V.(%)	0	19	24	0	16	37	8	17	31	6	0	0	54	2
MAX.	7	21	0.14	<0.04	0.5	48.4	31.0	0.23	2220	1.06	<0.4	<2	0.20	165.0
MIN.	7	16	0.10	<0.04	0.4	28.2	27.5	0.18	1430	0.98	<0.4	<2	0.09	161.0
- HEPATOPANCREAS														
MEAN(2)	11	23	0.87	2.90	0.8	343.5	261.5	0.22	2145	7.57	1.5	3	0.43	89.5
S.D.	3	12	0.19	1.41	0.2	238.3	27.6	0.01	120	1.10	1.1	1.4	0.32	11.5
C.V.(%)	26	53	22	49	28	69	11	6	6	14	73	47	75	13
MAX.	13	31	1.00	3.90	0.9	512.0	281.0	0.21	2230	8.34	2.2	4	0.65	97.6
MIN.	9	14	0.73	1.90	0.6	175.0	242.0	0.23	2060	6.79	0.7	<2	0.20	81.3
- GILL														
MEAN(2)	92	9	2.61	0.60	1.2	164.5	873.0	0.09	4255	5.18	0.9	2	0.93	128.5
S.D.	6	1	1.73	0.25	0.9	57.3	858.4	0.01	460	0.18	0.6	0	0.62	38.9
C.V.(%)	6	8	67	42	80	35	98	16	11	4	63	0	67	30
MAX.	96	9	3.83	0.78	1.8	205.0	1480.0	0.10	4580	5.31	1.3	<2	1.36	156.0
MIN.	88	8	1.38	0.42	0.5	124.0	266.0	0.08	3930	5.05	0.5	<2	0.49	101.0
VANTERM														
DUNGENESS CRAB (Cancer magister) - MUSCLE														
MEAN(2)	49	32	0.5	0.10	0.7	54.2	153.3	1.28	2125	1.69	0.5	2	0.23	225.5
S.D.	53	1	0.4	0.08	0	16.9	155.2	0.47	955	1.04	0.1	0	0.21	99.7
C.V.(%)	109	4	79	85	0	31	101	37	45	62	16	0	91	44
MAX.	86	33	0.7	0.16	0.7	66.1	263.0	1.61	2800	2.42	0.5	<2	0.37	296.0
MIN.	11	31	0.2	<0.04	0.7	42.2	43.5	0.94	1450	0.95	<0.4	<2	<0.08	155.0

APPENDIX IIIA Tissue Trace Metal Concentrations - Descriptive Statistics - Vancouver Harbour, May 1985.

	Concentration (µg/g dry weight)												
Station	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
					- HEPATOPANCREAS									
VALUE	98	51	1.02	3.9	0.9	888	613	1.06	1330	7.57	2.1	3	0.48	88.5
					- GILL									
MEAN(2)	5770	2	33.0	2.18	17.7	319	10820	0.38	7590	112.7	1.7	16	75	273.5
S.D.	4441	7	29.1	1.73	14.2	3	7608	0.19	3394	81.0	1.8	10	72	157.7
C.V.(%)	77	29	88	80	81	1	70	51	45	72	107	62	96	58
MAX.	8910	29	53.6	3.40	27.7	321	16200	0.51	9990	170.0	2.9	23	126	385.0
MIN.	2630	19	12.4	0.95	7.6	317	5440	0.24	5190	55.4	<0.4	9	24	162.0
CHEVRON (CV)														
DUNGENESS CRAB (*Cancer magister*) - MUSCLE														
VALUE	<5	14	0.20	0.46	2.1	56.2	33.3	0.28	1860	1.20	<0.5	<2	2.70	122.0
					- HEPATOPANCREAS									
VALUE	<40	<40	<0.80	4.00	<4.0	410.0	122.0	0.12	3400	7.00	<4.0	<20	1.76	60.0
					- GILL									
VALUE	18	5	0.69	0.4	2.1	156.0	84.6	0.10	3850	3.93	<0.4	<2	2.91	73.3
CATES PARK (CP)														
DUNGENESS CRAB (*Cancer magister*) - MUSCLE														
MEAN(3)	17	15	0.35	0.37	0.6	52.0	53	0.36	2133	1.4	0.4	2	1.81	186.7
S.D.	5	5	0.30	0.17	0.1	17.5	4	0.57	547	0.1	0	0	0.17	8.0
C.V.(%)	30	29	87	46	9	34	8	161	26	4	0	0	10	4
MAX.	22	20	0.70	0.56	0.7	71.3	57	1.02	2760	1.4	<0.4	<2	2.00	195.0
MIN.	12	11	0.15	0.22	0.6	37.1	49	<0.02	1750	1.3	<0.4	<2	1.66	179.0

APPENDIX IIIA Tissue Trace Metal Concentrations - Descriptive Statistics - Vancouver Harbour, May 1985.

Station	Concentration (µg/g dry weight) Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
					- HEPATOPANCREAS									
MEAN(3)	5	22	0.98	0.97	1.0	433.0	255	0.13	2530	8.9	2.3	4.3	2.96	165.8
S.D.	2	13	0.46	0.42	0.3	187.2	88	0.04	722	3.6	1.5	2.1	1.77	70.9
C.V.(%)	43	59	46	43	26	43	35	30	29	41	63	48	60	43
MAX.	8	34	1.51	1.30	1.3	595.0	309	0.18	3220	12.6	3.8	6	5.00	213.0
MIN.	<4	8	0.71	0.50	0.8	228.0	153	0.11	1780	5.4	0.9	<2	1.92	84.3
					- GILL									
MEAN(3)	114	4	1.78	0.52	0.8	220.7	562	0.15	5573	5.6	1.1	2	3.84	159.3
S.D.	57	0	0.57	0.13	0.1	23.5	195	0.18	160	2.0	0.3	0	0.21	24.6
C.V.(%)	50	0	32	24	13	11	35	122	3	35	31	0	6	15
MAX.	179	4	2.22	0.65	0.9	241.0	765	0.36	5740	7.9	1.3	<2	4.00	185.0
MIN.	70	<4	1.14	0.40	0.7	195.0	376	0.03	5420	4.4	0.7	<2	3.60	136.0
BOULDER ROCK (BR)														
DUNGENESS CRAB (Cancer magister) - MUSCLE														
MEAN(3)	43.7	12.7	0.2	0.2	0.6	48.7	90.4	-	1576.7	1.8	0.4	2	2	179.7
S.D.	6.7	6.4	0.1	0	0.1	6.3	25.7	-	112.4	0.7	0	0	0	27.3
C.V.(%)	15	51	50	0	13	13	28	-	7	40	0	0	0	15
MAX.	51.0	20.0	0.4	<.2	0.6	55.9	120.0	-	1700.0	2.6	<0.4	<2.0	<2.0	209.0
MIN.	38.0	8.0	0.1	<.2	0.5	44.0	73.9	-	1480.0	1.2	<0.4	<2.0	<2.0	155.0
					- HEPATOPANCREAS									
MEAN(3)	18.0	23.0	0.9	1.8	1.2	185.0	271.7	-	2613.3	10.1	1.0	2.7	2.7	139.8
S.D.	4.4	3.6	0.3	1.9	0.3	92.1	25.2	-	612.1	1.8	0.5	1.2	0.6	97.4
C.V.(%)	24	16	34	106	29	50	9	-	23	18	50	43	22	70
MAX.	23.0	26.0	1.2	4.0	1.6	274.0	295.0	-	3320.0	12.0	1.5	4.0	3.0	250.0
MIN.	15.0	19.0	0.6	0.6	1.0	90.0	245.0	-	2250.0	8.4	0.5	<2.0	<2.0	65.4

APPENDIX IIIA Tissue Trace Metal Concentrations - Descriptive Statistics - Vancouver Harbour, May 1985.

	Concentration (µg/g dry weight)													
Station	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
					- GILL									
MEAN(3)	469.3	10.0	3.5	1.5	1.6	219.0	1077.3	-	3340.0	16.8	0.4	2.3	7.3	427.7
S.D	478.8	2.0	1.7	1.9	1.3	138.7	1019.8	-	1802.2	4.9	0	0.6	6.1	386.2
C.V.(%)	102	20	49	132	78	63	95	-	54	29	0	25	83	90
MAX.	994.0	12.0	5.5	3.7	3.0	331.0	2180.0	-	4560.0	21.0	<.4	3.0	14.0	873.0
MIN.	56.0	8.0	2.5	0.3	0.5	63.9	168.0	-	1270.0	11.4	<.4	<2.0	<2.0	184.0
PORT MOODY (PM)														
DUNGENESS CRAB (Cancer magister) - MUSCLE														
MEAN(2	13	5	0.16	0.19	0.6	38.0	35.1	0.15	1385	0.92	0.4	2	1.17	147.5
S.D.	5	1	0.03	0.01	0	0.9	2.0	0.07	7	0.05	0	0	0.28	2.1
C.V.(%)	40	16	18	7	0	2	6	47	1	5	0	0	24	1
MAX.	16	5	0.18	0.20	0.6	38.6	36.5	0.20	1390	0.95	0.4	<2	1.37	149.0
MIN.	9	<4	0.14	0.18	0.6	37.3	33.7	0.10	1380	0.88	<0.4	<2	0.97	146.0
					- HEPATOPANCREAS									
MEAN(2)	8	18	0.84	1.15	1.1	98.6	267.5	0.14	1730	8.94	1.7	2	1.23	103.5
S.D.	4	6	0.16	0.21	0.1	106.6	34.6	0.01	311	3.91	1.0	0	0.16	0.7
C.V.(%)	47	31	19	18	7	108	13	5	18	44	170	0	13	1
MAX.	10	22	0.95	1.30	1.1	174.0	292.0	0.14	1950	11.70	1.8	<2	1.34	104.0
MIN.	5	14	0.72	1.00	1.0	23.2	243.0	0.13	1510	6.17	1.6	<2	1.12	103.0
					- GILL									
MEAN(2)	342	15	3.10	0.65	1.9	233.5	1570.0	0.12	4695	8.65	1.3	2	12.00	204.5
S.D.	4	2	0.18	0.21	0.1	75.7	410.1	0.04	148	0.52	2.1	0	2.83	20.5
C.V.(%)	1	15	6	33	4	32	26	31	3	6	150	0	24	10
MAX.	344	16	3.23	0.80	1.9	287.0	1860.0	0.14	4800	9.01	1.7	<2	14.00	219.0
MIN.	339	13	2.97	0.50	1.8	180.0	1280.0	0.09	4590	8.28	0.8	<2	10.00	190.0

APPENDIX IIIA Tissue Trace Metal Concentrations - Descriptive Statistics - Vancouver Harbour, May 1985.

Station	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
	Concentration (µg/g dry weight)													
SOLE AND FLOUNDER														
PACIFIC ENVIRONMENT INSTITUTE (PEI)														
ENGLISH SOLE (Parophrys vetulus) - MUSCLE														
VALUE	<4.0	19.0	<0.08	0.07	0.5	1.0	9.2	-	1440	0.82	<0.4	<2.0	<0.08	15.3
DOVER SOLE (Microstomus pacificus) - MUSCLE														
MEAN(6)	8.7	79.8	0.24	0.15	0.6	1.8	30.6	-	1323	1.86	0.4	2.0	0.16	21.8
S.D.	7.3	26.6	0.27	0.24	0.1	0.5	14.1	-	41	1.08	0	0	0.14	5.0
C.V.(%)	85	33	111	159	15	26	46	-	3	58	0	0	90	23
MAX.	20.0	121.0	0.77	0.65	0.7	2.2	53.1	-	1380	3.50	<0.4	<2.0	0.45	30.3
MIN.	<4.0	52.0	<0.08	0.04	0.5	1.0	18.2	-	1260	0.93	<0.4	<2.0	<0.08	17.6
ROCK SOLE (Lepidopsetta bilineata) - MUSCLE														
VALUE	<4.0	79.0	<0.08	0.10	0.7	0.9	11.2	-	1420	0.78	<0.4	<2.0	<0.08	14.7
- GILL														
VALUE	280.0	<10.0	1.10	0.20	2.0	8.0	665.0	-	1010	11.70	<1.0	<5.0	0.40	107.0
REX SOLE (Glyptocephalus zachirus) - MUSCLE														
MEAN(2)	4.0	61.5	0.12	0.08	0.7	1.3	22.2	-	1230	1.10	0.4	2.0	0.12	16.3
S.D.	0	8.5	0.04	0.02	0	0	12.8	-	60	0.08	0	0	0.04	1.6
C.V.(%)	0	14	33	25	8	4	58	-	5	7	0	0	33	10
MAX.	<4.0	70.0	0.16	0.10	0.7	1.3	35.0	-	1290	1.17	<0.4	<2.0	0.16	17.8
MIN.	<4.0	53.0	<0.08	0.06	0.6	1.2	9.3	-	1170	1.02	<0.4	<2.0	0.08	14.7
- LIVER														
VALUE	5.0	<4.0	<0.08	1.30	0.7	1.5	160.0	-	196	1.74	<0.4	<2.0	0.08	29.5
- GILL														
VALUE	106.0	48.0	0.80	0.33	1.1	5.6	302.0	-	1070	40.70	<0.5	<2.0	0.20	164.0

APPENDIX IIIA Tissue Trace Metal Concentrations - Descriptive Statistics - Vancouver Harbour, May 1985.

Station	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
	Concentration (μg/g dry weight)													
BURRARD YARROWS (BY)														
ENGLISH SOLE (Parophrys vetulus) - MUSCLE														
MEAN(2)	4	66	0.11	0.04	0.55	0.4	37.15	0.19	1190	0.7	0.4	2.0	0.12	24.15
S.D.	0	21	0.01	0	0.07	0	23.97	0.04	0	0.2	0	0	0.01	6.72
C.V.(%)	0	32	7	0	13	0	65	19	0	22	0	0	12	28
MAX.	<4	81	0.11	<0.04	0.60	<0.4	54.10	0.21	1190	0.8	<0.4	<2.0	0.13	28.90
MIN.	<4	51	0.10	<0.04	0.50	<0.4	20.20	0.16	1190	0.6	<0.4	<2.0	0.11	19.40
- LIVER														
MEAN(2)	22	19	1.17	2.15	0.7	22.1	282.5	0.06	696	4.08	0.6	2.0	0.81	108.0
S.D.	15	2	0.52	0.07	0.1	9.1	20.5	0.06	49	0.61	0.2	0	0.40	9.9
C.V.(%)	69	11	44	3	11	41	7	94	7	15	39	0	49	9
MAX.	32	20	1.53	2.2	0.7	28.5	297.0	0.10	731	4.51	0.7	<2.0	1.09	115.0
MIN.	11	17	<0.80	2.1	0.6	15.6	268.0	0.02	661	3.65	<0.4	<2.0	0.53	101.0
- GILL														
MEAN(2)	184	6	1.35	0.10	1.5	3.9	597.5	-	1570	10.4	0.6	2.0	0.35	82.3
S.D.	168	1	0.49	0.02	0.1	0.4	244.0	-	85	4.7	0.1	0	0.21	2.1
C.V.(%)	91	13	37	20	5	9	41	-	5	46	13	0	61	2
MAX.	302	<6	1.70	0.12	1.5	4.1	770.0	-	1630	13.7	0.6	<2.0	0.50	83.7
MIN.	65	<5	1.00	0.09	1.4	3.6	425.0	-	1510	7.0	0.5	<2.0	0.20	80.8
DOVER SOLE (Microstomus pacificus) - MUSCLE														
MEAN(2)	4	75	0.15	0.06	0.8	0.4	18.3	0.23	1170	0.8	0.4	2.0	0.2	23.2
S.D.	0	7	0.02	0	0.1	0	0.3	0.04	28	0.3	0	0	0.2	2.0
C.V.(%)	0	9	15	0	9	0	2	19	2	34	0	0	82	9
MAX.	<4	80	0.16	0.06	0.8	<0.4	18.5	0.26	1190	1.0	<0.4	<2.0	0.3	24.6
MIN.	<4	70	0.13	0.06	0.7	<0.4	18.1	0.20	1150	0.6	<0.4	<2.0	<0.08	21.8

APPENDIX IIIA Tissue Trace Metal Concentrations - Descriptive Statistics - Vancouver Harbour, May 1985.

Station	Concentration (µg/g dry weight)													
	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
						- LIVER								
MEAN(2)	23	33	0.51	2.10	0.6	15.1	600.0	0.14	834	3.70	1.2	2	0.73	96.6
S.D.	13	11	0.42	0.14	0.3	4.2	287.1	0.03	16	0.03	0.1	0	0.04	10.5
C.V.(%)	55	34	83	7	47	28	48	20	2	1	12	0	5	11
MAX.	32	41	0.80	2.20	0.8	18.0	803.0	0.16	845	3.72	1.3	<2	0.76	104.0
MIN.	14	25	0.21	2.00	0.4	12.1	397.0	0.12	823	3.68	1.1	<2	0.70	89.2
						- GILL								
MEAN(2)	42	8	0.25	0.16	1.0	1.6	331.0	0.03	1530	5.0	1.5	4	0.3	84.5
S.D.	12	4	0.07	0.06	0.1	0.8	48.1	0	57	0.4	0.7	2	0.1	2.3
C.V.(%)	29	47	28	35	7	53	15	0	4	8	47	6	33	3
MAX.	50	<10	0.30	0.20	1.0	2.2	365.0	<0.03	1570	5.3	2.0	<5	0.4	86.1
MIN.	33	<5	0.20	0.12	0.9	1.0	297.0	<0.03	1490	4.7	1.0	<2	0.2	82.9
ROCK SOLE (*Lepidopsetta bilineata*) - MUSCLE														
MEAN(2)	4	6	0.08	0.05	0.8	0.04	16.3	0.61	1405	0.57	0.4	2	0.4	18.0
S.D.	0	0	0	0.07	0.1	0	2.8	0.36	35	0.20	0	0	0.4	0.3
C.V.(%)	0	0	0	141	18	0	17	57	3	35	0	0	106	2
MAX.	<4	6	<0.08	0.09	0.9	<0.04	18.2	0.86	1430	0.71	<0.4	<2	0.6	18.2
MIN.	<4	6	<0.08	<0.04	0.7	<0.04	14.3	0.35	1380	0.43	<0.4	<2	0.1	17.8
						- LIVER								
MEAN(2)	4	83	0.08	0.69	0.7	17.3	380.5	0.45	968	5.71	0.4	2	0.31	122.5
S.D.	0	61	0	0.37	0.1	4.7	251.0	0.42	159	1.61	0	0	0.03	3.5
C.V.(%)	0	73	0	55	11	27	66	94	16	28	0	0	9	3
MAX.	<4	126	<0.08	0.95	0.7	20.6	558.0	0.75	1080	6.84	<0.4	<2	0.33	125.0
MIN.	<4	40	<0.08	0.42	0.6	14.0	203.0	0.15	855	4.57	<0.4	<2	0.29	120.0
						- GILL								
MEAN(2)	16	5	0.35	0.26	0.7	1.7	182.0	0.19	1115	5.04	0.5	2	0.24	84.0
S.D.	1	0	0.21	0.29	0.2	0.2	12.7	0.13	205	1.75	0	0	0.06	13.4

APPENDIX IIIA Tissue Trace Metal Concentrations - Descriptive Statistics - Vancouver Harbour, May 1985.

	Concentration (µg/g dry weight)													
Station	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
- GILL (continued)														
C.V.(%)	9	0	59	114	33	13	7	67	18	35	0	0	24	16
MAX.	17	<5	0.49	0.46	0.8	1.8	191.0	0.28	1260	6.27	<0.5	<2	0.28	93.4
MIN.	15	<5	0.20	0.05	<0.5	1.5	173.0	0.10	970	3.80	<0.5	<2	0.20	74.5
SANDDAB SOLE (Citharichthys spp.) - MUSCLE														
VALUE	<4	14	0.08	<0.04	0.4	<0.4	9.7	0.37	1480	0.42	<0.4	<2	<0.08	13.1
STARRY FLOUNDER (Platichthys stellatus) - MUSCLE														
VALUE	<4	6	0.08	0.07	0.5	<0.4	34.1	0.54	1250	0.78	<0.4	<2	<0.08	28.7
- LIVER														
VALUE	28	<4	0.19	4.5	0.5	81.7	1140.0	0.66	896	4.53	<0.4	<2	0.79	183.0
- GILL														
VALUE	28	<4	1.38	0.16	0.8	2	162.0	0.08	1130	13.6	<0.4	<2	0.15	95.0
COAL HARBOUR (CH)														
ENGLISH SOLE (Parophrys vetulus) - MUSCLE														
MEAN(5)	5	67	0.14	0.23	0.7	1.0	19.3	0.25	1093	2.15	0.4	2	1.12	22.3
S.D.	2	32	0.06	0.01	0.2	0.3	5.1	0.17	133	2.84	0	0	0.11	5.5
C.V.(%)	35	47	45	7	27	35	27	69	12	132	0	0	10	25
MAX.	8	98	0.23	0.25	1.0	1.4	25.5	0.52	1190	7.20	<0.4	<2	1.24	31.5
MIN.	<4	21	<0.08	0.21	0.5	0.7	13.1	0.12	867	0.55	<0.4	<2	0.97	17.1
- LIVER														
MEAN(3)	45	33	0.21	2.10	0.9	6.1	777.0	0.09	687	4.90	2.5	2	2.52	100.9
S.D.	50	9	0.21	0.53	0.4	2.2	131.3	0.02	162	0.96	0.2	0	2.18	8.4
C.V.(%)	111	28	100	25	40	36	17	22	24	20	9	0	87	8
MAX.	102	39	0.46	2.50	1.2	8.7	919.0	0.11	847	5.81	2.8	2	5.00	108.0
MIN.	14	22	<0.08	1.50	0.5	4.8	660.0	0.07	523	3.89	2.4	<2	0.87	91.6

APPENDIX IIIA Tissue Trace Metal Concentrations - Descriptive Statistics - Vancouver Harbour, May 1985.

Station	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
					Concentration (µg/g dry weight)									
					- GILL									
MEAN(3)	87	6	0.71	0.30	1.3	4.8	458.7	0.06	1587	14.6	1.7	2	3.00	79.3
S.D.	25	1.7	0.31	0.11	0.5	2.7	67.4	0.03	71	10.1	0.5	1	0	15.7
C.V.(%)	29	29	43	35	38	56	15	44	4	69	30	25	0	20
MAX.	114	<8	1.02	0.40	1.8	7.8	502.0	0.08	1650	25.2	2.0	<3	3.00	96.6
MIN.	65	<5	0.40	0.19	0.8	2.6	381.0	<0.03	1510	5.1	<0.5	<2	<3.00	65.8
DOVER SOLE (Microstomus pacificus) - MUSCLE														
MEAN(4)	4	61	0.12	0.27	0.7	1.0	40.9	0.24	1075	0.79	0.4	2	1.32	20.7
S.D.	1	23	0.06	0.04	0.1	0.3	42.2	0.07	17	0.58	0.1	0	0.13	4.2
C.V.(%)	22	38	53	14	20	29	103	30	2	74	12	0	10	20
MAX.	6	84	0.21	0.31	0.8	1.3	104.0	0.34	1090	1.63	0.5	<2	1.47	26.0
MIN.	<4	29	<0.08	0.23	0.5	0.7	16.7	0.17	1050	0.30	<0.4	<2	1.21	15.8
					- LIVER									
VALUE	17	25	<0.08	1.90	1.0	18.6	937.0	0.18	555	3.99	2.4	<2	6.00	123.0
					- GILL									
VALUE	70	<5	0.30	0.23	1.3	4.7	493.0	0.05	1210	5.60	1.4	<2	1.60	77.2
ROCK SOLE (Lepidopsetta bilineata) - MUSCLE														
VALUE	<4	106	<0.08	0.14	1.1	1.7	14.8	1.24	1190	0.98	<0.4	<2	0.98	31.4
					- LIVER									
VALUE	7	166	<0.08	5.60	1.0	139.0	897.0	0.53	825	8.03	1.2	<2	1.57	294.0
STARRY FLOUNDER (Platichthys stellatus) - MUSCLE														
MEAN(2)	30	14	0.96	0.26	1.2	1.7	75.6	0.96	1330	3.68	0.4	2	1.21	47.9
S.D	37	14	1.10	0.04	0.2	0.6	71.3	0.75	156	3.98	0	0	0.11	23.8
C.V.(%)	123	100	115	14	18	33	94	78	12	108	0	0	9	50
MAX.	56	24	1.73	0.28	1.3	2.1	126.0	1.49	1440	6.49	0.4	<2	1.29	64.7
MIN.	<4	<4	0.18	0.23	1.0	1.3	25.2	0.43	1220	0.86	<0.4	<2	1.13	31.1

APPENDIX IIIA Tissue Trace Metal Concentrations - Descriptive Statistics - Vancouver Harbour, May 1985.

	Concentration (μg/g dry weight)													
Station	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
						- LIVER								
MEAN(2)	21	29	0.25	16.40	1.1	43.5	3385.0	-	875	5.00	9.8	2	1.30	213.5
S.D.	16	15	0.21	13.15	0	22.8	1704.1	-	35	0.57	5.4	0	0	58.7
C.V.(%)	79	52	85	80	0	53	50	-	4	11	55	0	0	27
MAX.	32	39	0.40	25.70	1.1	59.6	4590.0	1.77	900	5.40	13.6	<2	1.30	255.0
MIN.	9	18	0.10	7.10	1.1	27.3	2180.0	1.77	850	4.60	6.0	<2	1.30	172.0
						- GILL								
MEAN(2)	184	6	1.75	0.48	1.7	5.0	538.5	-	1285	13.00	1.7	2	2.10	118.4
S.D.	145	1	1.34	0.03	0.4	2.2	212.8	-	64	4.53	0.5	0	1.27	27.7
C.V.(%)	79	13	77	6	25	44	40	-	5	35	30	0	61	23
MAX.	286	<6	2.70	0.50	2.0	6.5	689.0	0.80	1330	16.20	2.0	<2	3.00	138.0
MIN.	81	<5	0.80	0.46	1.4	3.4	388.0	0.80	1240	9.80	1.3	<2	1.20	98.8
STERLING (ST)														
ENGLISH SOLE (*Parophrys vetulus*) - MUSCLE														
MEAN(4)	17	66	0.13	0.51	0.9	2.1	34.4	0.34	1225	0.65	0.4	2	0.12	28.4
S.D.	19	3	0.06	0.94	0.4	0.8	16.6	0.12	87	0.16	0	0	0.06	8.9
C.V.(%)	114	5	49	184	45	37	48	36	7	24	0	0	55	31
MAX.	45	70	0.22	1.91	1.4	3.0	50.5	0.51	1320	0.81	<0.4	<2	0.21	38.9
MIN.	<4	64	0.09	<0.04	0.6	1.3	15.4	0.23	1110	0.44	<0.4	<2	0.08	20.3
					- LIVER									
MEAN(2)	62	42	0.35	2.30	0.9	20.7	252.0	0.24	965	5.68	1.2	2	0.85	110.8
S.D.	67	29	0.35	0.57	0.2	20.4	21.2	0.08	64	0.25	0.4	0	0.64	28.6
C.V.(%)	109	70	100	25	25	99	8	33	7	4	31	0	76	26
MAX.	109	62	0.60	2.70	1.0	35.1	267.0	0.29	1010	5.85	1.4	<2	1.30	131.0
MIN.	14	21	<0.10	1.90	0.7	6.2	237.0	0.18	920	5.50	0.9	<2	0.39	90.5

APPENDIX IIIA Tissue Trace Metal Concentrations - Descriptive Statistics - Vancouver Harbour, May 1985.

	Concentration (µg/g dry weight)													
Station	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
ROCK SOLE (Lepidopsetta bilineata) - MUSCLE														
MEAN(2)	4	26	0.08	0.04	0.7	1.0	11.1	0.50	1235	0.58	0.4	2	0.18	24.1
S.D.	0	28	0	0	0.2	0.1	4.2	0.09	78	0.06	0	0	0.14	8.8
C.V.(%)	0	109	0	0	33	7	38	19	6	10	0	0	79	37
MAX.	<4	46	<0.08	<0.04	0.8	1.0	14.0	0.56	1290	0.62	<0.4	<2	0.28	30.3
MIN.	<4	6	<0.08	<0.04	0.5	0.9	8.1	0.43	1180	0.54	<0.4	<2	0.08	17.8
- LIVER														
MEAN(2)	10	31	0.08	1.56	0.9	19.7	831.0	-	984	4.50	0.5	2	0.65	120.0
S.D.	8	21	0	1.62	0.3	6.4	903.7	-	376	2.26	0.1	0	0.57	25.5
C.V.(%)	85	67	0	104	31	33	109	-	38	50	28	0	89	21
MAX.	16	45	<0.08	2.70	1.1	24.2	1470.0	0.28	1250	6.10	0.6	<2	1.05	138.0
MIN.	<4	16	<0.08	0.41	0.7	15.1	192.0	0.28	718	2.90	<0.4	<2	0.24	102.0
- GILL														
VALUE	<6	<6	0.10	0.09	<0.6	3.5	329.0	0.16	860	3.90	<0.6	<2	0.30	70.4
PETRALE SOLE (Eopsetta jordani) - MUSCLE														
MEAN(2)	4	26	0.14	0.04	0.6	2.0	14.2	0.60	1355	1.00	0.4	2	0.11	20.6
S.D.	0	1	0.05	0	0.1	1.1	1.2	0.15	21	0.35	0	0	0.03	0
C.V.(%)	0	3	37	0	13	57	8	25	2	35	0	0	26	0
MAX.	4	26	0.17	<0.04	0.6	2.8	15.0	0.70	1370	1.24	<0.4	<2	0.13	20.6
MIN.	<4	25	0.10	<0.04	0.5	1.2	13.3	0.49	1340	0.75	<0.4	<2	0.09	20.6
- LIVER														
VALUE	6	60	<0.08	<0.04	0.6	2.3	24.3	0.31	1230	0.58	0.4	<2	0.21	37.5
VANTERM (VT)														
ENGLISH SOLE (Parophrys vetulus) - MUSCLE														
MEAN(2)	25	84	0.16	0.08	0.9	0.4	59.1	0.25	1265	1.09	0.4	4	0.08	19.5
S.D.	8	24	0.01	0.05	0.1	0	8.0	0.05	7	0.37	0	2	0.01	3.3

APPENDIX IIIA Tissue Trace Metal Concentrations - Descriptive Statistics - Vancouver Harbour, May 1985.

	Concentration (µg/g dry weight)													
Station	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
- MUSCLE (continued)														
C.V.(%)	32	29	5	66	8	0	14	20	1	34	0	61	8	17
MAX.	30	101	0.16	0.11	0.9	<0.4	64.7	0.28	1270	1.35	<0.4	5	<0.09	21.8
MIN.	19	67	0.15	<0.04	0.8	<0.4	53.4	0.21	1260	0.83	<0.4	<2	<0.08	17.2
- LIVER														
VALUE	55	8	0.25	1.20	0.9	19.3	1070	0.34	856	4.53	0.8	<2	5.0	117
- GILL														
VALUE	891	<5	4.3	0.09	2.9	24.6	1640	-	1880	20.1	0.5	2	4.0	74.6
DOVER SOLE (Microstomus pacificus) - MUSCLE														
VALUE	49	46	0.26	<0.04	0.8	<0.4	87.5	0.11	1460	1.91	<0.4	<2	<0.08	20.4
STARRY FLOUNDER (Platichthys stellatus) - MUSCLE														
VALUE	31	5	0.18	<0.04	0.7	4	69.1	1.02	1260	1.45	<0.4	<2	0.16	47.2
- LIVER														
VALUE	36	<6	0.2	6.20	1.7	140	1830	5.20	870	5.40	0.9	17	0.4	258
CHEVRON (CV)														
ENGLISH SOLE (Parophrys vetulus) - MUSCLE														
MEAN(3)	6	25	0.22	0.19	2.1	1.7	22.5	0.40	1097	2.41	0.4	2	1.23	5.1
S.D.	4	14	0.14	0.05	1.1	0.5	5.5	0.30	148	2.22	0	0	0.27	2.6
C.V.(%)	64	57	61	27	51	27	24	77	14	92	0	0	22	51
MAX.	11	41	0.37	0.24	3.1	2.2	28.8	0.65	1260	4.95	<0.4	<2	1.53	7.7
MIN.	<4	16	0.10	0.14	1.0	1.3	18.8	0.06	970	0.88	<0.4	<2	1.00	2.5
- LIVER														
MEAN(3)	51	45	0.09	5.10	1.3	15.6	1268.0	0.41	720	5.05	1.3	3	1.51	86.0
S.D.	61	21	0.01	1.61	0.2	7.7	1198.0	0.26	61	1.25	0.9	1	0.18	12.1
C.V.(%)	120	47	12	32	16	50	94	63	8	25	71	22	12	14

APPENDIX IIIA Tissue Trace Metal Concentrations - Descriptive Statistics - Vancouver Harbour, May 1985.

Station	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
	Concentration (µg/g dry weight)													
						- LIVER (continued)								
MAX.	120	69	<0.10	6.80	1.5	24.5	2560.0	0.66	780	6.30	2.3	<3	1.63	95.2
MIN.	7	31	<0.08	3.60	1.1	10.9	194.0	0.14	659	3.80	0.7	<2	1.30	72.3
						- GILL								
MEAN(3)	39	7	0.23	0.19	3.1	3.3	287.7	0.18	1010	6.53	0.7	3	1.33	46.5
S.D.	6	1	0.06	0.03	1.6	1.4	220.3	0.06	142	1.42	0.1	0	0.35	6.0
C.V.(%)	17	8	25	16	50	44	77	31	14	22	8	0	26	13
MAX.	43	<8	0.30	0.22	4.7	4.9	540.0	0.22	1170	7.50	<0.8	<3	1.70	51.8
MIN.	34	<7	<0.20	0.16	1.6	2.3	134.0	<0.03	900	4.90	<0.7	<3	1.00	40.0
REX SOLE (Glyptocephalus zachirus) - MUSCLE														
MEAN(3)	4	12	0.13	0.17	1.6	2.0	19.1	0.61	1370	2.14	0.4	2	1.42	0.2
S.D.	0	6	0.06	0.01	0.5	1.3	6.2	0.18	50	1.53	0	0	0.15	0
C.V.(%)	0	52	41	7	32	63	32	29	4	72	0	0	10	0
MAX.	<4	18	0.19	0.18	2.2	3.3	26.3	0.75	1420	3.84	<0.4	<2	1.59	<0.2
MIN.	<4	6	0.08	0.16	1.3	0.8	15.5	0.41	1320	0.88	<0.4	<2	1.31	<0.2
						- LIVER								
MEAN(3)	7	37	0.13	0.87	2.8	7.2	331.7	0.19	553	8.37	0.8	3	0.93	27.1
S.D.	0.6	17	0.06	0.15	0.4	2.6	219.1	0.12	106	4.61	0	0	0.21	16.9
C.V.(%)	8	47	43	18	14	35	66	63	19	55	0	0	22	62
MAX.	<8	47	<0.20	1.00	3.2	9.7	547.0	0.31	650	13.60	0.8	<3	1.10	40.0
MIN.	<7	17	<0.10	0.70	2.4	4.6	109.0	0.07	440	4.90	<0.8	<3	0.70	8.0
						- GILL								
MEAN(3)	14	6	2.14	0.23	4.6	3.1	101.3	0.20	1230	29.07	0.6	3	0.79	40.8
S.D.	5	2	0.82	0.16	1.7	1.2	20.9	0.09	210	3.51	0.2	1	0.08	13.0
C.V.(%)	37	29	38	70	38	39	21	48	17	12	29	22	10	32
MAX.	19	<7	2.93	0.42	6.1	4.5	124.0	0.27	1380	32.70	0.7	<3	0.86	50.8
MIN.	9	<4	1.30	0.12	2.7	2.4	82.8	0.09	990	25.70	<0.4	<2	0.70	26.1

APPENDIX IIIA Tissue Trace Metal Concentrations - Descriptive Statistics - Vancouver Harbour, May 1985.

	Concentration (μg/g dry weight)													
Station	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
ROUGHSCALE SOLE (Clidoderma asperrimum) - MUSCLE														
MEAN(3)	4.3	31	0.10	0.15	0.7	0.8	12.4	0.37	1053	0.96	0.5	2	1.05	14.6
S.D.	0.6	4	0.02	0.03	0.2	0.2	1.3	0.27	83	0.56	0.1	0	0.15	2.2
C.V.(%)	13	13	20	21	21	30	10	73	8	58	12	0	14	15
MAX.	<5	33	0.12	0.18	0.9	0.9	13.3	0.68	1120	1.59	0.5	<2	1.19	16.5
MIN.	<4	26	<0.10	0.12	0.6	0.5	10.9	0.19	960	0.50	<0.4	<2	0.90	12.2
- LIVER														
MEAN(3)	7.3	91	0.09	4.07	1.0	22.6	1214.0	0.48	640	4.16	2.0	3	1.48	122.0
S.D.	3.5	44	0.01	2.20	0.3	14.2	600.6	0.26	50	1.11	1.2	1	0.25	11.1
C.V.(%)	48	48	12	54	30	63	49	55	8	27	60	22	17	9
MAX.	11	138	<0.10	6.60	1.3	38.9	1600.0	0.78	690	5.38	3.3	<3	1.70	132.0
MIN.	<4	51	<0.08	2.70	0.8	13.4	522.0	0.30	590	3.20	1.1	<2	1.20	110.0
- GILL														
MEAN(3)	7	8	0.13	0.20	3.0	3.4	160.7	0.16	1143	5.27	0.7	3	1.17	85.3
S.D.	0.6	0	0.06	0	2.1	0.3	33.3	0.13	275	1.93	0.1	0	0.15	6.0
C.V.(%)	8	0	43	0	72	9	21	85	24	37	8	0	13	7
MAX.	<8	8	<0.20	0.20	5.4	3.7	189.0	0.31	1450	6.80	<0.8	<3	1.30	92.2
MIN.	<7	<8	0.10	0.20	1.5	3.2	124.0	0.07	920	3.10	<0.7	<3	1.00	81.2
CATES PARK (CP)														
ENGLISH SOLE (Parophrys vetulus) - MUSCLE														
MEAN(3)	5	50	0.24	0.21	0.7	1.1	20	0.23	1303	1.3	0.4	2	1.59	24.0
S.D.	2	25	0.07	0.02	0.1	0.3	3	0.17	145	0.5	0	0	0.14	2.8
C.V.(%)	43	49	29	11	9	24	15	74	11	37	0	0	9	11
MAX.	8	74	0.31	0.22	0.7	1.3	23	0.42	1470	1.8	<0.4	<2	1.67	26.7
MIN.	<4	25	0.17	0.18	0.6	0.8	17	0.08	1210	0.9	<0.4	<2	1.43	21.2
- LIVER														
MEAN(3)	24	64	0.09	3.00	0.7	20.5	1408	0.10	755	3.7	2.0	2	1.75	121.3
S.D.	8	22	0.02	1.21	0.1	9.6	933	0.11	96	0.6	1.1	0	0.43	33.0
C.V.(%)	31	35	19	40	18	47	66	114	13	15	54	0	24	27

APPENDIX IIIA Tissue Trace Metal Concentrations - Descriptive Statistics - Vancouver Harbour, May 1985.

Station	Concentration (µg/g dry weight) Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
- LIVER (CONTINUED)														
MAX.	31	84	0.11	4.30	0.7	27.2	2340	0.23	865	4.2	3.1	<2	2.23	155.0
MIN.	16	40	<0.08	1.90	0.6	9.5	474	<0.02	689	3.1	1.0	<2	1.40	89.0
- GILL														
MEAN(3)	20	7	0.50	0.14	1.4	3.1	261	0.06	1190	4.5	0.8	3	0.93	72.6
S.D.	15	0.6	0.28	0	0.1	0.5	38	0.04	233	0.5	0.2	0	0.32	4.0
C.V.(%)	76	8	57	0	10	15	15	71	20	11	28	0	34	6
MAX.	30	<8	0.70	0.14	1.5	3.6	292	0.09	1450	5.0	1.1	<3	1.30	76.4
MIN.	<8	<7	<0.20	0.14	<0.8	2.7	218	0.03	1000	4.0	<0.7	<3	0.70	68.4
ROCK SOLE (Lepidopsetta bilineata) - MUSCLE														
MEAN(3)	4	48	0.17	0.37	0.6	0.8	28	0.21	1343	0.9	0.4	2	1.55	19.7
S.D.	0	22	0.08	0.33	0.1	0.2	28	0.03	38	0.3	0.1	0	0.25	2.4
C.V.(%)	0	46	47	89	9	20	103	16	3	35	13	0	16	12
MAX.	<4	70	0.22	0.75	0.7	0.9	61	0.25	1370	1.2	0.5	<2	1.74	21.7
MIN.	<4	26	<0.08	0.16	0.6	0.6	10	0.19	1300	0.7	<0.4	<2	1.27	17.0
- LIVER														
MEAN(3)	6	34	0.09	1.23	0.6	21.5	1987	0.25	615	2.8	2.2	2.7	1.23	127.7
S.D.	2	37	0.01	0.25	0.3	7.2	403	0.06	122	0.7	0.7	0.6	0.16	6.0
C.V.(%)	29	110	12	20	47	33	20	22	20	24	33	22	13	5
MAX.	<7	77	0.10	1.50	0.8	27.5	2450	0.30	690	3.4	2.8	<3	1.40	134.0
MIN.	4	11	<0.08	1.00	0.4	13.6	1720	0.19	474	2.1	1.4	<2	1.10	122.0
- GILL														
MEAN(3)	9	7	0.17	0.25	1.1	3.3	233	0.08	1760	4.7	0.8	3	1.53	95.7
S.D.	2	0	0.06	0.06	0.2	0.5	46	0	964	0.4	0.1	0	0.12	7.5
C.V.(%)	22	0	35	23	18	14	20	0	55	8	15	0	8	8
MAX.	11	<7	0.20	0.32	1.3	3.8	279	0.08	2860	5.0	0.9	<3	1.60	101.0
MIN.	<7	<7	0.10	0.22	0.9	2.9	187	0.08	1060	4.3	<0.7	<3	1.40	87.1

APPENDIX IIIA Tissue Trace Metal Concentrations - Descriptive Statistics - Vancouver Harbour, May 1985.

	Concentration (µg/g dry weight)													
Station	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
FLATHEAD SOLE (Hippoglossoides ellasodon) - MUSCLE														
VALUE	<4	27	<0.08	0.14	0.6	1.0	15	0.57	1360	0.6	<0.4	<2	1.16	16.6
- LIVER														
VALUE	<8	57	<0.2	2.70	0.9	76.0	1070	0.13	970	4.9	1.2	<3	1.40	172.0
- GILL														
VALUE	18	<7	0.10	0.22	1.4	2.5	123	0.08	1490	5.1	0.9	<3	1.20	80.6
BOULDER ROCK (BR)														
ENGLISH SOLE (Parophrys vetulus) - MUSCLE														
MEAN(3)	41.3	41.3	0.39	0.04	0.6	2.0	77.2	-	1360.0	2.2	0.4	2.0	0.23	32.3
S.D.	45.5	23.0	0.39	0	0.3	0.6	62.4	-	235.8	2.2	0	0	0.15	10.2
C.V.(%)	110	56	100	0	44	31	81	-	17	99	0	0	66	32
MAX.	93.0	65.0	0.84	<0.04	0.9	2.7	148.0	-	1620.0	4.7	<0.4	<2.0	0.41	42.6
MIN.	7.0	19.0	0.14	<0.04	0.4	1.5	30.1	-	1160.0	0.7	<0.4	<2.0	0.13	22.2
- LIVER														
MEAN(3)	29.7	23.0	0.10	2.6	0.5	14.6	525.0	-	709.0	3.8	0.4	2.0	2.11	103.2
S.D.	24.2	12.1	0.02	1.3	0.1	1.9	567.3	-	99.0	0.4	0	0	2.50	9.4
C.V.(%)	82	53	20	50	20	13	108	-	14	11	0	0	119	9
MAX.	57.0	34.0	0.12	3.8	0.6	16.4	1180.0	-	788.0	4.1	<0.4	<2.0	5.00	110.0
MIN.	11.0	10.0	<0.08	1.2	0.4	12.7	191.0	-	598.0	3.3	<0.4	<2.0	0.66	92.5
- GILL														
MEAN(3)	164.3	4.7	1.06	1.5	1.1	5.2	482.3	-	1436.7	7.5	0.4	2.0	0.42	73.4
S.D.	95.0	0.6	0.46	0.9	0.3	1.9	153.4	-	110.2	2.1	0.1	0	0.03	3.6
C.V.(%)	58	12	43	58	27	37	32	-	8	27	13	0	6	5
MAX.	274.0	5.0	1.34	<2.0	1.4	6.6	655.0	-	1510.0	9.7	<0.5	<2.0	0.45	76.7
MIN.	106.0	<4.0	0.53	0.5	0.8	3.0	362.0	-	1310.0	5.7	<0.4	<2.0	0.40	69.6
ROCK SOLE (Lepidopsetta bilineata) - MUSCLE														
MEAN(3)	22.0	78.0	0.14	0.2	0.5	1.7	46.9	-	1326.7	1.0	0.4	2.0	0.14	23.5
S.D.	6.1	39.5	0.04	0	0.1	0.6	11.2	-	47.3	0.1	0	0	0.03	3.5

APPENDIX IIIA Tissue Trace Metal Concentrations - Descriptive Statistics - Vancouver Harbour, May 1985.

	Concentration (µg/g dry weight)													
Station	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
						- MUSCLE (continued)								
C.V.(%)	28	51	25	0	20	39	24	-	4	8	0	0	19	15
MAX.	26.0	118.0	0.18	0.2	0.6	2.4	58.2	-	1380.0	1.1	<0.4	<2.0	0.16	27.1
MIN.	15.0	39.0	0.11	0.2	0.4	1.2	35.8	-	1290.0	0.9	<0.4	<2.0	0.11	20.1
						- LIVER								
MEAN(3)	18.0	80.3	0.13	1.3	0.5	17.8	867.3	-	686.0	3.4	0.5	2	3.0	105.2
S.D.	8.2	75.2	0.06	0.4	0.1	13.5	800.4	-	14.4	0.3	0.1	0	1.0	10.8
C.V.(%)	45	94	51	33	11	76	92	-	2	9	12	0	33	10
MAX.	25.0	167.0	0.20	1.6	0.6	33.3	1790.0	-	698.0	3.8	<0.5	<2.0	4.0	116.0
MIN.	9.0	32.0	<0.08	0.8	<0.5	8.4	360.0	-	670.0	3.2	<0.4	<2.0	2.0	94.5
						- GILL								
MEAN(3)	126.7	7.3	2.1	0.08	1.4	4.8	270.0	-	1533.3	7.7	0.4	2	7.0	81.8
S.D.	81.0	4.2	1.2	0.02	0.3	1.9	125.5	-	232.5	2.2	0.1	0	1.0	12.7
C.V.(%)	64	57	55	25	18	40	46	-	15	29	13	0	14	16
MAX.	209.0	12.0	3.4	0.10	1.6	7.0	405.0	-	1710.0	9.8	<0.5	<2.0	8.0	91.1
MIN.	47.0	4.0	1.1	0.06	1.1	3.3	157.0	-	1270.0	5.4	<0.4	<2.0	6.0	67.3
C-O SOLE (Pleuronichthys coenosus) - MUSCLE														
MEAN(2)	-	15	0.12	0.04	0.4	1.6	25	-	1205.0	0.54	0.4	2	0.12	16.1
S.D.	-	1	0	0	0	0	10	-	64.0	0.12	0	0	0.05	0.6
C.V.(%)	-	5	0	0	0	0	39	-	5	22	0	0	43	4
MAX.	12	15	0.12	<0.04	0.4	1.6	32	-	1250.0	0.62	<0.4	<2	0.15	16.5
MIN.	<4	14	0.12	<0.04	<0.4	1.6	18	-	1160.0	0.45	<0.4	<2	0.08	15.6
						- LIVER								
VALUE	41.0	17.0	<.08	5.5	<.4	53.0	1720.0	-	685.0	3.4	<0.4	<2.0	4.0	163.0
PORT MOODY (PM)														
ENGLISH SOLE (Parophrys vetulus) - MUSCLE														
MEAN(3)	7	123	0.09	0.19	0.6	1.2	25.7	0.25	1301	0.59	0.4	2	1.32	22.1
S.D.	6	96	0.01	0.06	0.2	0.4	6.3	0.04	330	0.20	0.1	0	0.42	6.1

APPENDIX IIIA Tissue Trace Metal Concentrations - Descriptive Statistics - Vancouver Harbour, May 1985.

Station	Concentration (µg/g dry weight) Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
					- MUSCLE (continued)									
C.V.(%)	79	78	13	33	27	30	24	14	25	34	13	0	32	28
MAX.	14	232	0.10	0.24	0.7	1.5	33.0	0.29	1570	0.80	<0.5	<2	1.58	27.2
MIN.	<4	55	<0.08	0.12	<0.4	0.8	21.8	0.22	932	0.40	<0.4	<2	0.84	15.3
					- LIVER									
MEAN(3)	14	48	0.08	1.23	0.6	8.3	469.0	0.20	607	3.10	0.8	2	2.24	92.8
S.D.	12	50	0	0.61	0.2	2.4	297.1	0.01	294	1.52	0.3	0	1.34	46.2
C.V.(%)	82	105	0	50	29	29	63	7	48	49	25	0	60	50
MAX.	27	106	<0.08	1.90	0.7	10.7	771.0	0.21	810	4.37	1.0	<2	3.64	128.0
MIN.	5	15	<0.08	0.70	<0.4	5.9	177.0	0.19	270	1.42	0.6	<2	0.96	40.5
					- GILL									
MEAN(3)	111	8	1.16	0.18	1.5	4.2	494.3	0.05	1450	8.30	0.8	3	0.99	76.3
S.D.	29	3	0.89	0.04	0.9	0.7	71.4	0.03	139	3.57	0.3	2	0.35	1.3
C.V.(%)	26	43	77	23	60	16	14	54	10	43	43	62	35	2
MAX.	144	<10	2.19	0.20	2.6	5.0	540.0	0.07	1540	12.40	<1.0	<5	1.38	77.5
MIN.	90	<4	0.60	0.13	1.0	3.7	412.0	<0.02	1290	5.90	<0.4	<2	0.70	74.9
STARRY FLOUNDER (Platichthys stellatus) - MUSCLE														
MEAN(2)	7	17	0.13	0.19	0.6	1.3	31.2	0.22	1155	0.77	0.4	2	1.25	21.0
S.D.	4	2	0.01	0.02	0.1	0.3	13.2	0.03	219	0.26	0	0	0.25	5.4
C.V.(%)	54	13	6	11	24	22	42	13	19	34	0	0	20	26
MAX.	9	18	0.13	0.20	0.7	1.5	40.5	0.24	1310	0.95	<0.4	<2	1.43	24.8
MIN.	<4	15	0.12	0.17	0.5	1.1	21.9	0.20	1000	0.58	<0.4	<2	1.07	17.1
						- LIVER								
MEAN(2)	21	6	0.10	2.15	0.9	78.1	1630.0	0.25	793	4.30	1.8	2	2.45	189.0
S.D.	11	1	0.03	1.20	0.1	39.5	226.3	0.17	4	1.21	0.1	0	1.10	48.1
C.V.(%)	52	13	28	56	8	51	14	67	1	28	8	0	45	25
MAX.	28	6	0.12	3.00	0.9	106.0	1790.0	0.37	796	5.15	1.9	<2	3.22	223.0
MIN.	13	5	<0.08	1.30	0.8	50.2	1470.0	0.13	790	3.44	1.7	<2	1.67	155.0

APPENDIX IIIA Tissue Trace Metal Concentrations - Descriptive Statistics - Vancouver Harbour, May 1985.

	Concentration (µg/g dry weight)												
Station	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
						- GILL								
MEAN(2)	68	4	0.33	0.26	1.0	5.0	411.0	0.05	1080	9.31	0.4	2	2.89	84.7
S.D.	38	0	0.11	0.04	0.2	2.3	8.5	0	99	5.50	0.1	0	1.12	12.2
C.V.(%)	56	0	33	14	22	45	2	0	9	59	16	0	39	14
MAX.	95	<4	0.40	0.28	1.1	6.6	417.0	0.05	1150	13.20	0.5	<2	3.68	93.3
MIN.	41	<4	0.25	0.23	0.8	3.4	405.0	0.05	1010	5.42	<0.4	<2	2.09	76.0
OTHER FISH SPECIES														
PACIFIC ENVIRONMENT INSTITUTE (PEI)														
RATFISH (Hydrolagus colliei) - MUSCLE														
MEAN(5)	7.4	63.4	0.08	0.44	0.6	1.7	27.5	-	1079	1.00	0.4	2.0	0.09	14.4
S.D.	3.6	19.5	0.01	0.42	0.4	·1.3	11.0	-	81	0.13	0	0	0.03	0.6
C.V.(%)	48	31	11	96	68	75	40	-	7	13	0	0	29	4
MAX.	12.0	88.0	0.10	1.18	1.4	4.0	38.2	-	1160	1.15	<0.4	<2.0	0.14	15.2
MIN.	<4.0	34.0	<0.08	0.18	<0.4	1.0	13.8	-	947	0.81	<0.4	<2.0	<0.08	13.8
				- LIVER										
MEAN(5)	2.6	8.6	0.05	0.34	0.3	2.5	114.1	-	29	0.32	0.3	1.0	0.07	4.2
S.D.	0.5	1.3	0.01	0.19	0.1	0.3	32.9	-	5	0.05	0.1	0	0.03	0.6
C.V.(%)	21	15	9	55	21	14	29	-	17	16	21	0	40	14
MAX.	<3.0	10.0	<0.06	0.56	<0.3	3.0	156.0	-	35	0.38	<0.3	<1.0	0.11	5.0
MIN.	<2.0	7.0	<0.05	0.14	<0.2	2.2	80.9	-	24	0.27	<0.2	<1.0	<0.05	3.7
				- GILL										
MEAN(5)	98.8	16.2	0.51	0.07	0.6	6.4	307.2	-	825	11.68	0.4	2.6	0.13	48.2
S.D.	60.5	2.7	0.39	0.04	0.2	1.6	107.2	-	123	7.91	0	0.9	0.05	8.3
C.V.(%)	61	17	77	62	36	25	35	-	15	68	0	34	36	17
MAX.	188.0	20.0	1.17	0.15	0.9	8.0	449.0	-	986	20.30	<0.4	4.0	0.18	57.4
MIN.	38.0	14.0	0.18	<0.04	<0.4	4.2	163.0	-	668	3.68	<0.4	<2.0	<0.08	35.2

APPENDIX IIIA Tissue Trace Metal Concentrations - Descriptive Statistics - Vancouver Harbour, May 1985.

	Concentration (µg/g dry weight)												
Station	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
BLACK COD (Anoplopoma fimbria) - MUSCLE														
VALUE	<4.0	<4.0	0.31	<0.04	0.4	1.6	28.3	-	1490	1.33	<0.4	<2.0	<0.08	18.6
- LIVER														
VALUE	<4.0	6.0	<0.08	7.60	0.5	15.3	1040.0	-	708	4.38	<0.4	<2.0	<0.08	109.0
- GILL														
VALUE	110.0	<5.0	5.30	0.49	1.3	5.8	459.0	-	1640	17.20	<0.5	<2.0	<0.10	83.1
POLLOCK (Theragra chalcogramma) - MUSCLE														
VALUE	<4.0	12.0	<0.08	0.14	0.4	2.5	12.6	-	1660	0.78	<0.4	<2.0	<0.08	18.5
- LIVER														
VALUE	<4.0	6.0	<0.08	<0.04	<0.4	8.6	147.0	-	180	6.35	<0.4	<2.0	0.10	45.2
- GILL														
VALUE	34.0	5.0	1.20	0.78	1.0	28.3	396.0	-	1330	15.80	<0.5	2.0	0.30	88.4
DOGFISH (Squalus acathias) - MUSCLE														
MEAN(2)	5.0	15.5	0.08	0.04	0.4	2.4	22.6	-	449	0.42	0.4	2.0	0.10	7.3
S.D.	1.4	10.6	0	0	0	0.2	7.2	-	83	0.11	0	0	0.02	0.1
C.V.(%)	28	68	0	0	0	9	10	-	19	27	0	0	22	2
MAX.	6.0	23.0	<0.08	<0.04	<0.4	2.5	24.1	-	508	0.50	<0.4	<2.0	0.11	7.4
MIN	<4.0	8.0	<0.08	<0.04	<0.4	2.2	21.0	-	390	0.34	<0.4	<2.0	<0.08	7.2
- LIVER														
MEAN(2)	3.0	7.0	0.05	0.53	0.3	2.0	48.0	-	41	0.38	0.3	1.0	0.05	6.6
S.D.	1.4	4.2	0	0.31	0.1	1.2	15.2	-	6	0	0.1	0	0	0.5
C.V.(%)	47	61	0	59	28	62	32	-	14	0	28	0	0	8
MAX.	4.0	10.0	<0.05	0.75	<0.3	2.8	58.7	-	45	0.38	<0.3	<1.0	<0.05	6.9
MIN.	<2.0	4.0	<0.05	0.31	<0.2	1.1	37.2	-	37	0.38	<0.2	<1.0	<0.05	6.2

APPENDIX IIIA Tissue Trace Metal Concentrations - Descriptive Statistics - Vancouver Harbour, May 1985.

Station	Concentration (µg/g dry weight) Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
LONGNOSE SKATE (*Raja rhina*) - MUSCLE														
MEAN(3)	5.3	76.7	0.11	0.19	0.5	1.5	24.2	-	1137	1.02	0.4	2.0	0.08	13.8
S.D.	2.3	17.0	0.03	0.23	0.1	0.3	9.0	-	110	0.28	0	0	0.01	1.5
C.V.(%)	43	22	27	119	20	23	37	-	10	27	0	0	7	11
MAX.	8.0	87.0	0.14	0.45	0.6	1.9	34.4	-	1210	1.32	<0.4	<2.0	0.09	15.1
MIN.	4.0	57.0	0.08	0.05	0.4	1.3	17.3	-	1010	0.77	<0.4	<2.0	0.08	12.1
- LIVER														
MEAN(4)	3.0	11.0	0.07	0.29	0.3	10.6	84.4	-	117	1.23	0.3	1.5	0.07	16.9
S.D.	1.2	4.1	0.02	0.23	0.1	4.5	52.8	-	92	0.81	0.1	0.6	0.02	10.4
C.V.(%)	38	37	27	81	38	42	63	-	79	66	38	38	22	62
MAX.	4.0	15.0	0.08	0.60	0.4	15.2	149.0	-	214	1.99	0.4	2.0	0.08	26.9
MIN.	2.0	7.0	0.05	0.05	0.2	5.6	39.6	-	38	0.44	0.2	1.0	0.05	6.9
COAL HARBOUR (CH)														
TOMCOD (*Microgadus proximus*) - MUSCLE														
MEAN(2)	5	5	0.10	0.21	0.7	1.6	25.8	0.48	1450	0.94	0.4	2	1.06	27.4
S.D.	1.4	0	0.04	0.02	0.3	1.5	8.1	0.22	99	0.35	0	0	0.04	9.2
C.V.(%)	28	0	34	10	40	96	31	46	7	37	0	0	3	34
MAX.	6	5	0.13	0.23	0.9	2.6	31.5	0.63	1520	1.18	<0.4	<2	1.08	33.9
MIN.	<4	5	<0.08	<0.20	0.5	0.5	20.1	0.32	1380	0.69	<0.4	<2	1.03	20.9
WALLEYE POLLOCK (*Theragra chalcogramma*) - MUSCLE														
MEAN(3)	9	23	0.16	0.22	0.9	0.9	34.3	0.54	1407	2.10	0.4	2	1.11	19.2
S.D.	6	2	0.04	0.01	0.3	0.2	10.9	0.16	23	0.33	0	0	0.04	2.2
C.V.(%)	62	8	25	5	27	16	32	29	2	16	0	0	4	11
MAX.	15	24	0.21	0.23	1.2	1.1	45.5	0.65	1420	2.47	<0.4	<2	1.16	20.8
MIN.	<4	21	0.13	0.21	0.7	0.8	23.8	0.36	1380	1.85	<0.4	<2	1.08	16.7
DOGFISH (*Squalus acathias*) - MUSCLE														
VALUE	<4	84	0.10	0.26	0.9	1.8	9.1	2.59	636	0.62	<0.4	<2	0.62	14.7

APPENDIX IIIA Tissue Trace Metal Concentrations - Descriptive Statistics - Vancouver Harbour, May 1985.

Station	Concentration (µg/g dry weight)													
	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
- LIVER														
VALUE	<4	41	<0.09	1.80	0.5	10.6	134.0	0.31	157	2.80	<0.4	<2	0.12	24.9
- GILL														
VALUE	15	34	0.31	1.1	4.0	126.0	0.71	-	1010	4.25	<0.4	<2	1.16	82.9
STERLING (ST)														
PACIFIC COD (Gadus macrocephalus) - MUSCLE														
MEAN(2)	6	6	0.17	0.04	0.6	1.9	26.0	0.60	1495	1.43	0.4	2	1.04	23.0
S.D.	3	1	0.09	0	0.1	0.8	10.1	0.15	35	0.65	0	0	1.36	1.1
C.V.(%)	47	13	56	0	24	42	39	25	2	45	0	0	131	5
MAX.	8	6	0.23	<0.04	0.7	2.4	33.1	0.70	1520	1.89	<0.4	<2	<2.00	23.7
MIN.	<4	5	0.10	<0.04	0.5	1.3	18.8	0.50	1470	0.97	<0.4	<2	<0.08	22.2
TOMCOD (Microgadus proximus) - MUSCLE														
MEAN(2)	5	9	0.08	0.04	0.6	1.8	17.6	0.57	1530	0.63	0.4	2	0.09	28.3
S.D.	1	4	0	0	0.1	0	2.6	0.33	14	0.06	0	0	0.01	0
C.V.(%)	16	42	0	0	13	0	15	59	1	10	0	0	8	0
MAX.	5	11	<0.08	<0.04	0.6	1.8	19.4	0.80	1540	0.67	<0.4	<2	0.09	28.3
MIN.	<4	6	<0.08	<0.04	0.5	1.8	15.7	0.33	1520	0.58	<0.4	<2	<0.08	28.3
DOGFISH (Squalus acathias) - MUSCLE														
VALUE	<4	19	0.10	<0.04	0.4	2.4	18.2	2.88	553	0.40	<0.4	<2	0.15	10.1
- LIVER														
VALUE	20	25	<0.08	3.70	<0.4	8.3	215.0	2.16	202	2.29	0.7	<2	0.20	32.9
- GILL														
VALUE	18	8	1.57	0.13	0.9	3.5	178.0	1.40	1140	5.42	<0.4	<2	<0.08	57.9

APPENDIX IIIA Tissue Trace Metal Concentrations - Descriptive Statistics - Vancouver Harbour, May 1985.

	Concentration (µg/g dry weight)													
Station	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
VANTERM (VT)														
DOGFISH (Squalus acathias) - MUSCLE														
MEAN(2)	5	16	0.12	0.04	0.4	1.65	17.3	3.26	569	0.42	0.4	2	0.10	8.0
S.D.	1	3	0.04	0	0	1.77	2.3	0.23	58	0.04	0	0	0.02	0.2
C.V.(%)	20	19	33	0	0	107	13	7	10	10	0	0	20	3
MAX.	6	19	0.16	<0.04	0.4	2.90	19.9	3.42	627	0.46	<0.4	<2	0.12	8.2
MIN.	<4	13	<0.08	<0.04	0.4	<0.4	15.0	3.09	511	0.37	<0.4	<2	<0.08	7.7
- LIVER														
MEAN(2)	15	30	0.09	3.1	0.4	12.0	338	2.83	203	1.91	0.8	2	0.12	30.9
S.D.	15	8	0.01	0.6	0	2.3	11	3.30	1	0.31	0	0	0.06	1.9
C.V.(%)	102	26	8	21	0	20	3	117	1	16	0	0	47	6
MAX.	25	35	0.09	3.5	<0.4	13.6	345	5.16	204	2.13	0.8	<2	0.16	32.2
MIN.	<4	24	<0.08	2.6	<0.4	10.3	330	0.49	202	1.69	0.8	<2	<0.08	29.5
- GILL														
MEAN(2)	633	11	2.57	0.30	2.5	13.3	1153	1.66	1490	14.3	0.6	3	0.66	63.3
S.D.	195	4	0.62	0.09	0.8	4.2	434	0.29	42	4.0	0.1	1	0.29	4.5
C.V.(%)	31	34	24	31	32	32	38	18	3	28	13	47	44	7
MAX.	771	13	3.01	0.36	3.0	16.3	1460	1.86	1520	17.1	0.6	4	0.86	66.5
MIN.	495	8	2.13	0.23	1.9	10.3	846	1.45	1460	11.5	0.5	<2	0.45	60.1
CATES PARK (CP)														
TOMCOD (Microgadus proximus) - MUSCLE														
MEAN(2)	4	6	0.08	0.17	0.5	1.0	20	0.19	1640	1.0	0.4	2	1.55	26.3
S.D.	0.7	0	0.01	0.01	0.1	0.1	1	0.06	42	0.2	0.1	1	0.06	0.7
C.V.(%)	20	0	9	8	16	7	7	30	3	24	35	47	4	3
MAX.	<4	6	<0.08	0.18	0.5	1.0	21	0.23	1670	1.1	<0.4	<2	1.59	26.8
MIN.	<3	6	<0.07	0.16	0.4	0.9	19	0.15	1610	0.8	<0.3	<1	1.50	25.8

APPENDIX IIIA **Tissue Trace Metal Concentrations - Descriptive Statistics - Vancouver Harbour, May 1985.**

	Concentration (µg/g dry weight)													
Station	**Al**	**As**	**Ba**	**Cd**	**Cr**	**Cu**	**Fe**	**Hg**	**Mg**	**Mn**	**Mo**	**Ni**	**Pb**	**Zn**
					- LIVER									
MEAN(2)	7.5	21	0.2	0.90	0.8	75.5	838	-	825	4.3	1.4	3	2.50	155.0
S.D.	0.7	5	0.1	0.14	0.1	7.3	124	-	49	0.7	0.8	0	0.57	8.5
C.V.(%)	9	24	47	16	18	10	15	-	6	16	58	0	23	5
MAX.	<8	24	<0.2	1.00	0.9	80.6	925	-	860	4.8	1.9	<3	2.90	161.0
MIN.	<7	17	<0.1	0.80	<0.7	70.3	750	-	790	3.8	0.8	<3	2.10	149.0
					- GILL									
MEAN(2)	60	6	1.51	0.19	1.3	4.8	194	0.05	1580	8.8	0.6	2	0.99	98.1
S.D.	50	2	0.98	0.10	0.7	2.5	81	0	467	4.4	0.2	1	0.16	5.5
C.V.(%)	84	39	65	52	54	53	42	0	30	50	39	28	16	6
MAX.	95	<7	2.20	0.26	1.8	6.6	251	0.05	1910	11.9	<0.7	<3	1.10	102.0
MIN.	24	<4	0.82	0.12	0.8	3.0	136	0.05	1250	5.6	<0.4	<2	0.88	94.2
PACIFIC COD (Gadus macroephalus) - MUSCLE														
MEAN(2)	5	5	0.09	0.18	0.4	1.3	28	0.42	1505	1.2	0.4	2	1.53	17.5
S.D.	1	1	0.01	0	0	0.1	14	0.17	7	0.2	0	0	0.21	0.6
C.V.(%)	28	16	8	0	0	6	51	40	0	13	0	0	13	3
MAX.	6	5	0.09	0.18	0.4	1.3	38	0.54	1510	1.3	<0.4	<2	1.67	17.9
MIN.	<4	4	<0.08	0.18	<0.4	1.2	18	0.30	1500	1.1	<0.4	<2	1.38	17.1
					- LIVER									
MEAN(2)	4	15	0.08	0.62	0.5	6.7	168	0.08	469	7.0	0.8	2	1.20	72.9
S.D.	0	6	0	0.25	0.1	0.1	49	0.06	156	1.1	0.1	0	0.30	9.1
C.V.(%)	0	38	0	41	16	1	29	85	33	16	18	0	25	12
MAX.	<4	19	<0.08	0.80	0.5	6.7	203	0.12	579	7.8	0.9	<2	1.41	79.3
MIN.	<4	11	<0.08	0.44	<0.4	6.6	133	0.03	358	6.2	0.7	<2	0.99	66.5

APPENDIX IIIA Tissue Trace Metal Concentrations - Descriptive Statistics - Vancouver Harbour, May 1985.

	Concentration (μg/g dry weight)													
Station	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
						- GILL								
MEAN(2)	14	4	1.90	0.11	1.4	2.3	109	0.09	1615	27.7	0.4	2	0.66	76.6
S.D.	2	0	0.26	0.01	0.1	0.2	1	0.03	148	6.3	0	0	0.10	5.7
C.V.(%)	16	0	14	13	5	9	1	31	9	23	0	0	15	7
MAX.	15	<4	2.08	0.12	1.4	2.4	109	0.11	1720	32.1	<0.4	<2	0.73	80.6
MIN.	12	<4	1.71	0.10	1.3	2.1	108	0.07	1510	23.2	<0.4	<2	0.59	72.6
WALLEYE POLLOCK (Theragra chalcogramma) - MUSCLE														
VALUE	<4	10	0.10	0.18	0.5	2.0	28	0.57	1370	1.0	<0.4	<2	1.25	23.5
						- LIVER								
VALUE	<4	11	<0.08	0.80	<0.4	62.9	193	0.08	345	5.9	0.5	<2	0.37	78.9
						- GILL								
VALUE	46	<4	1.77	0.26	1.2	6.4	245	<0.03	1730	18.3	<0.4	<2	0.62	82.9
BOULDER ROCK (BR)														
PACIFIC COD (Gadus macrocephalus) - MUSCLE														
VALUE	49.0	7.0	0.45	<0.2	0.8	3.4	102	-	1440.0	2.8	<0.4	<2.0	2.0	36.7
						- LIVER								
VALUE	57.0	25.0	0.37	1.4	0.8	9.2	628	-	774.0	8.3	<0.4	3.0	4.0	93.2
						- GILL								
VALUE	81.0	6.0	1.83	<0.2	1.9	2.8	186	-	1430.0	18.3	<0.4	2.0	3.0	70.7
PORT MOODY (PM)														
WALLEYE POLLOCK (Theragra chalcogramma) - MUSCLE														
MEAN(2)	4	17	0.09	0.18	0.5	1.8	29.8	0.57	1355	0.75	0.4	2	1.26	24.2
S.D.	0	2	0.01	0.04	0	0.1	0.6	0.15	106	0.21	0	0	0.27	3.4
C.V.(%)	0	13	16	24	0	4	2	26	8	28	0	0	21	14

APPENDIX IIIA   Tissue Trace Metal Concentrations - Descriptive Statistics - Vancouver Harbour, May 1985.

	Concentration (μg/g dry weight)													
Station	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
						- MUSCLE (continued)								
MAX.	<4	18	0.10	0.21	0.5	1.8	30.2	0.67	1430	0.89	<0.4	<2	1.45	26.6
MIN.	<4	15	<0.08	0.15	0.5	1.7	29.3	0.46	1280	0.60	<0.4	<2	1.07	21.8
						- LIVER								
MEAN(2)	4	6	0.08	0.26	0.5	25.5	97.0	0.06	258	3.25	0.4	2	0.22	50.5
S.D.	0	0	0	0.20	0.1	12.9	38.3	0.02	94	1.71	0	0	0.20	10.8
C.V.(%)	0	0	0	76	16	50	39	39	37	53	0	0	90	21
MAX.	<4	6	<0.08	0.40	0.5	34.6	124.0	0.07	324	4.46	<0.4	<2	0.36	58.1
MIN.	<4	6	<0.08	0.12	<0.4	16.4	69.9	0.04	191	2.04	<0.4	<2	<0.08	42.8
						- GILL								
MEAN(2)	153	7	2.81	0.14	1.5	5.9	412.0	0.06	1840	15.90	0.7	4	0.70	117.3
S.D.	38	4	2.41	0.08	0.7	3.0	264.5	0.03	679	7.64	0.4	2	0.01	34.9
C.V.(%)	25	61	86	61	47	52	64	47	37	48	61	61	1	30
MAX.	180	<10	4.51	0.20	2.0	8.0	599.0	0.08	2320	21.30	<1.0	<5	0.70	142.0
MIN.	126	<4	1.10	0.08	1.0	3.7	225.0	0.04	1360	10.50	<0.4	2	0.69	92.6
	PACIFIC COD (Gadus macrocephalus) - MUSCLE													
MEAN(2)	5	4	0.13	0.15	0.4	0.9	22.5	0.37	1280	1.16	0.4	2	0.92	19.5
S.D.	1	0	0.07	0.06	0	0.1	5.1	0.33	297	0.47	0	0	0.48	2.9
C.V.(%)	16	0	54	44	0	16	23	91	23	41	0	0	52	15
MAX.	5	<4	0.18	0.19	0.4	1.0	26.1	0.60	1490	1.49	<0.4	<2	1.26	21.5
MIN.	<4	<4	<0.08	0.10	0.4	0.8	18.9	0.13	1070	0.82	<0.4	<2	0.58	17.4
						- LIVER								
MEAN(2)	4	4	0.10	0.16	0.4	2.7	103.4	0.06	295	3.25	0.4	2	0.26	39.0
S.D.	0	0	0.03	0.40	0	0.8	50.4	0.05	68	0.56	0	0	0.03	9.6
C.V.(%)	0	0	28	88	0	29	49	90	23	17	0	0	11	25
MAX.	<4	4	0.12	0.26	<0.4	3.2	139.0	0.09	343	3.64	0.4	<2	0.28	45.8
MIN.	<4	<4	<0.08	0.06	<0.4	2.1	67.7	<0.02	247	2.85	<0.4	<2	0.24	32.2

APPENDIX IIIA Tissue Trace Metal Concentrations - Descriptive Statistics - Vancouver Harbour, May 1985.

	Concentration (μg/g dry weight)													
Station	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
- GILL														
VALUE	30	<10	5.10	<0.1	2.0	2.0	134.0	<0.03	1740	35.40	<1.0	<5	<0.20	79.4
DOGFISH (Squalus acathias) - MUSCLE														
VALUE	<4	18	<0.08	0.07	<0.4	1.2	18.2	4.02	526	0.38	<0.4	<2	0.48	10.4
- LIVER														
VALUE	8	21	<0.08	0.60	<0.4	11.8	169.0	1.21	164	2.06	<0.4	<2	0.10	19.7
- GILL														
VALUE	19	13	1.25	0.23	0.7	5.2	182.0	0.63	1070	4.50	<0.4	<2	1.37	73.7

APPENDIX IIIB **Tissue Trace Metal Concentrations - Descriptive Statistics - Vancouver Harbour, October 1985**

Station	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	Ti	V	Zn
							Concentration (µg/g dry weight)												
SHRIMP																			
PACIFIC ENVIRONMENT INSTITUTE (PEI)																			
SIDESTRIPE SHRIMP (Pandalus dispar) - MUSCLE																			
MEAN(7)	13	50	0.43	0.12	0.4	0.6	20.4	34.2	0.21	1390	1.09	0.5	2	0.14	0.8	12.40	7.4	0.4	49.8
S.D.	4	14	0.57	0.03	0	0	3.0	12.9	0.07	103	0.12	0.2	0	0.06	0	4.1	0.4	0	1.5
C.V.(%)	34	28	132	26	0	6	15	38	32	7	11	93	0	43	0	33	6	0	3
MAX.	19	73	1.63	0.16	<0.4	0.7	26.7	52.5	0.34	1530	1.23	0.8	<2	0.23	<0.8	20.6	8.2	<0.4	52.1
MIN.	8	34	0.10	0.08	<0.4	0.6	17.2	20.0	0.14	1230	0.93	<0.4	<2	<0.08	<0.8	8.5	6.8	<0.4	48.3
- HEPATOPANCREAS																			
MEAN(4)	24	43	0.22	31.1	0.6	0.9	648	91.3	0.21	480	8.0	1.0	3	0.9	1	8.5	6.7	0.6	85.4
S.D.	23	5	0.10	18.8	0.1	0.4	343	64.8	0.09	117	1.3	0.4	0.5	0.2	0	2.7	5.7	0.1	10.7
C.V(%)	99	13	43	60	15	44	53	71	42	24	17	39	18	16	0	31	85	15	12
MAX.	58	49	0.30	55.5	<0.7	1.4	1000	166.0	0.31	600	9.4	1.4	<3	1.1	<1	11.5	12.6	<0.7	97.5
MIN.	<7	38	<0.10	11.8	<0.5	<0.5	227	50.0	0.14	340	6.4	0.7	<2	0.8	<1	6.4	1.2	<0.5	77.5
PINK SHRIMP (Pandalus borealis) - MUSCLE																			
MEAN(6)	8	40	0.10	0.08	0.42	0.6	21.5	20.8	0.27	1383	1.06	0.4	2	0.16	0.8	8.64	7.7	0.42	53.3
S.D.	5	7	0.05	0.03	0.04	0.1	1.2	6.9	0.06	45	0.17	0.1	0	0.17	0.1	0.31	0.6	0.04	2.9
C.V.(%)	58	17	49	35	10	8	6	33	23	3	16	45	0	101	10	4	8	10	5
MAX.	15	54	0.2	0.11	<0.5	0.7	23.3	30.1	0.38	1440	1.23	0.6	<2	0.17	<1.0	9.05	8.7	<0.5	58.5
MIN.	<4	36	<0.08	0.05	<0.4	0.6	19.8	11.2	0.23	1310	0.91	<0.4	<2	<0.08	<0.8	8.24	6.9	<0.4	49.6
- HEPATOPANCREAS																			
MEAN(4)	115	28	0.6	8.3	1.0	1.0	399	346	0.20	455	8.8	1.8	3	0.5	1	8.1	10.4	0.9	60.7
S.D.	183	5	0.8	3.1	0.4	0.4	95	335	0.02	135	4.7	0.4	0	0.2	0	2.7	7.5	0.4	4.8
C.V.(%)	159	16	126	37	36	36	24	97	7	30	54	21	0	49	0	33	72	42	8
MAX.	389	33	1.8	12.3	1.5	1.5	522	848	0.22	650	14.2	2.2	<3	0.7	<1	11.7	21.6	1.5	66.3
MIN.	16	22	0.2	5.8	<0.7	<0.7	304	168	0.19	340	5.5	1.4	<3	0.2	<1	5.2	5.9	0.7	55.2

APPENDIX IIIB Tissue Trace Metal Concentrations - Descriptive Statistics - Vancouver Harbour, October 1985

Station	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	Ti	V	Zn
	Concentration (µg/g dry weight)																		
SMOOTH PINK SHRIMP (Pandalus jordani) - MUSCLE																			
MEAN(4)	17	27	0.13	0.07	0.4	0.6	24.7	36.0	0.16	1353	1.3	0.4	2	0.15	0.8	11.3	8.2	0.4	51.7
S.D.	6	4	0.03	0.03	0	0.1	0.1	10.1	0.03	52	0.2	0	0	0.08	0	0.2	0.2	0	1.1
C.V.(%)	37	13	26	39	0	9	1	28	17	4	15	0	0	55	0	2	3	0	2
MAX.	22	30	0.15	0.11	<0.4	0.6	24.8	43.4	0.19	1400	1.5	<0.4	<2	0.24	<0.8	11.4	8.5	<0.4	52.5
MIN.	9	22	<0.08	0.05	<0.4	0.5	24.5	21.4	0.13	1290	1.1	<0.4	<2	0.08	<0.8	11.1	7.9	<0.4	50.5
BURRARD NARROWS (BY)																			
COONSTRIPE SHRIMP (Pandalus danae) - MUSCLE																			
MEAN(6)	11	15	0.19	0.17	0.4	0.5	19.8	27.4	0.54	1420	1.11	0.42	2	0.10	0.8	23.8	7.8	0.4	53.4
S.D.	6	3	0.17	0.18	0	0.1	3.7	9.8	0.03	51	0.24	0.04	0	0.02	0	30.3	0.2	0	3.8
C.V.(%)	51	17	87	147	0	15	19	36	6	4	22	10	0	26	0	127	16	0	7
MAX.	20	18	0.52	0.06	<0.4	0.6	24.3	40.5	0.58	1500	1.45	0.5	<2	0.14	<0.8	85.3	8.9	<0.4	59.6
MIN.	<4	12	<0.08	<0.04	<0.4	0.4	14.6	16.4	0.50	1360	0.91	<0.4	<2	<0.08	<0.8	7.7	5.4	<0.4	49.1
- HEPATOPANCREAS																			
MEAN(4)	18	16	0.28	4.8	1.8	0.7	356	413	0.21	592	6.1	1.7	3	0.6	1.0	11.9	4.9	1.2	72.3
S.D.	11	5	0.07	1.6	0.8	0	68	93	0.19	108	1.0	0.5	0.5	0.4	0.1	2.4	2.1	0.6	3.2
C.V.(%)	62	29	25	33	46	0	19	23	89	18	16	27	18	64	10	20	44	52	4
MAX.	30	22	0.34	7.0	2.6	0.7	435	508	0.49	729	7.2	2.4	<3	1.1	<1	14.5	8.0	2.1	75.7
MIN.	8	12	0.20	3.3	<0.7	<0.7	269	297	0.11	480	5.4	1.4	<2	0.4	<0.8	9.8	3.5	0.7	69.4
COAL HARBOUR (CH)																			
HUMPBACK SHRIMP (Pandalus hypsinotus) - MUSCLE																			
MEAN(6)	19	19	0.18	0.04	0.4	0.5	18.0	40.6	0.10	1430	1.31	0.4	2	0.10	0.8	21.8	7.9	0.4	52.8
S.D.	10	7	0.10	0.01	0	0.1	2.8	11.4	0.04	49	0.31	0	0	0.02	0	18.8	0.6	0	2.9
C.V.(%)	51	34	56	12	0	15	16	28	40	3	24	0	0	23	0	86	7	0	5
MAX.	34	32	0.38	0.05	<0.4	0.6	21.9	55.3	0.18	1520	1.75	<0.4	<2	0.13	<0.8	60.0	8.6	<0.4	56.0
MIN.	9	14	0.11	<0.04	<0.4	<0.4	13.6	26.1	0.06	1390	1.00	<0.4	<2	<0.09	<0.8	11.6	6.9	<0.4	49.1

APPENDIX IIIB Tissue Trace Metal Concentrations - Descriptive Statistics - Vancouver Harbour, October 1985

Station	Concentration (µg/g dry weight)																		
	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	Ti	V	Zn
- HEPATOPANCREAS																			
MEAN(4)	16	13	0.2	3.2	0.8	0.8	274	155	0.13	420	5.7	1.1	3	0.2	2	7.8	3.7	0.8	64.9
S.D.	4	2	0	1.2	0.1	0.1	100	61	0.04	61	0.8	0.5	0	0.1	1	0.6	0.4	0.1	4.9
C.V(%)	25	19	0	39	8	6	37	39	30	14	13	46	0	25	54	8	12	8	8
MAX.	20	15	0.2	4.8	<0.8	0.8	405	232	0.17	490	6.6	1.8	<3	0.3	3	8.6	4.1	<0.8	68.8
MIN.	11	10	<0.2	1.9	<0.7	<0.7	169	86	0.09	360	5.0	<0.7	<3	<0.2	<1	7.2	3.1	<0.7	57.7
COONSTRIPE SHRIMP (Pandalus danae) - MUSCLE																			
MEAN(6)	12	14	0.10	0.05	0.4	0.6	22.1	27.6	0.27	1425	1.03	0.5	2	0.09	0.8	10.36	7.1	0.4	47.4
S.D.	6	4	0.01	0.01	0	0.1	3.5	6.8	0.08	74	0.13	0.1	0	0.01	0	1.72	1.6	0	4.5
C.V.(%)	48	26	14	25	0	19	16	25	29	5	13	22	0	14	0	17	22	0	10
MAX.	21	19	0.12	0.06	<0.4	0.7	26.1	39.0	0.40	1560	1.23	0.6	<2	0.11	<0.8	13.20	8.1	<0.4	52.1
MIN.	5	9	<0.08	<0.04	<0.4	<0.4	16.2	19.5	0.24	1360	0.85	<0.4	<2	<0.08	<0.8	8.64	4.0	<0.4	39.1
- HEPATOPANCREAS																			
MEAN(4)	8	18	0.2	7.2	1.5	0.8	324	378	0.17	473	5.4	0.8	3	1.2	2	8.3	3.7	0.8	74.6
S.D.	1	6	0.05	7.5	0.1	0.1	150	129	0.03	38	0.6	0.1	0	0.8	1	1.2	0.3	0.1	7.5
C.V.(%)	9	30	29	105	9	18	46	34	15	8	10	8	0	70	55	14	9	8	10
MAX.	8	22	0.2	18.4	1.6	1.0	490	478	0.20	520	6.0	<0.8	<3	1.9	<2	8.9	4.0	<0.8	82.5
MIN.	<7	10	<0.1	2.3	<0.8	<0.7	128	193	0.14	430	4.9	<0.7	<3	0.4	<1	6.5	3.2	<0.7	64.6
SMOOTH PINK SHRIMP (Pandalus jordani) - MUSCLE																			
MEAN(6)	14	19	0.10	0.04	0.4	0.6	20.5	33.4	0.24	1393	1.11	0.4	2	0.09	0.8	10.8	6.1	0.4	46.3
S.D.	6	2	0.02	0	0	0.2	2.5	10.0	0.04	30	0.11	0	0	0.01	0	1.4	2.3	0	2.4
C.V.(%)	39	11	19	0	0	29	12	30	19	2	10	0	0	14	0	13	38	0	5
MAX.	19	22	0.12	<0.04	<0.4	0.9	24.6	44.2	0.29	1440	1.23	<0.4	<2	0.11	<0.8	12.7	8.9	<0.4	49.1
MIN.	5	16	<0.08	<0.04	<0.4	<0.4	18.1	16.4	0.18	1350	0.97	<0.4	<2	<0.08	<0.8	9.0	3.1	<0.4	42.3
- HEPATOPANCREAS																			
MEAN(5)	7	7	0.14	0.92	0.7	0.9	141	56.7	0.08	170	3.0	0.7	3	0.4	1.6	2.6	7.8	0.7	34.7
S.D.	1	1	0.05	0.34	0.1	0.3	34	11.1	0.02	16	0.4	0.1	0	0.1	0.9	0.4	0.2	0.1	7.8
C.V.(%)	7	7	39	37	7	29	24	19	25	9	14	7	0	20	56	15	3	7	23

APPENDIX IIIB Tissue Trace Metal Concentrations - Descriptive Statistics - Vancouver Harbour, October 1985

Station	Concentration (µg/g dry weight)																	
	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	Ti	V	Zn
- HEPATOPANCREAS (continued)																			
MAX.	<8	<8	0.2	1.5	<0.8	1.3	188	69.3	0.11	190	3.4	0.8	<3	0.5	3	2.9	8.1	<0.8	44.9
MIN.	<7	<7	<0.1	0.6	<0.7	<0.7	101	41.1	0.06	150	2.5	<0.7	<3	0.3	<1	1.9	7.5	<0.7	27.8
STERLING (ST)																			
COONSTRIPE SHRIMP (Pandalus danae) - MUSCLE																			
MEAN(6)	13	20	0.16	0.08	0.5	0.9	20.3	24.6	0.19	1505	1.21	0.5	2	0.14	0.8	13.40	6.7	0.4	52.1
S.D.	4	6	0.05	0.02	0.1	0.4	2.4	5.8	0.08	58	0.17	0.2	0.4	0.10	0.1	7.30	1.0	0.1	6.3
C.V.(%)	31	29	29	23	26	40	12	24	43	4	14	36	19	72	10	54	15	27	12
MAX.	19	28	0.23	0.10	<0.7	1.6	24.7	31.4	0.28	1570	1.50	0.8	<3	0.34	<1.0	25.50	8.1	<0.7	63.3
MIN.	10	13	0.11	0.05	<0.4	0.6	18.2	17.0	0.10	1420	1.01	<0.4	<2	<0.08	<0.8	6.24	5.5	<0.4	44.8
- HEPATOPANCREAS																			
MEAN(5)	21	24	0.3	7.68	2.66	1.2	340.2	559.2	0.12	624	7.7	2.8	3	0.42	1.8	9.96	5.4	1.3	74.4
S.D.	8	6	0.1	4.60	1.34	0.7	101.2	195.3	0.04	98	1.5	0.8	0	0.16	0.4	1.76	1.6	0.8	8.4
C.V.(%)	41	24	24	60	50	58	30	35	34	16	19	28	0	39	25	18	30	60	11
MAX.	34	30	0.4	14.20	4.40	2.4	520.0	848.0	0.18	780	9.4	4.1	3	0.60	<2	12.60	7.1	2.6	86.3
MIN.	13	16	0.2	2.70	1.20	<0.8	279.0	344.0	0.07	550	6.1	2.0	<3	<0.20	<1	8.20	3.5	<0.7	64.3
PORT MOODY																			
COONSTRIPE SHRIMP (Pandalus danae) - MUSCLE																			
MEAN(6)	18	13	0.51	0.24	0.6	1.0	20.3	39.2	0.11	1594	1.18	0.7	2.6	0.18	1.3	33.3	6.1	0.6	55.1
S.D.	6	3	0.31	0.08	0.2	0.3	1.3	12.6	0.01	157	0.22	0.3	0.5	0.08	0.6	35.0	1.1	0.9	3.5
C.V.(%)	34	22	62	32	25	27	7	32	10	10	19	39	19	48	45	105	19	29	6
MAX.	30	16	0.90	0.34	0.5	1.3	21.8	57.5	0.12	1850	1.60	1.1	<3	0.30	<2	100.0	7.3	<0.8	60.8
MIN.	14	9	0.20	0.15	<0.7	<0.8	17.9	26.7	0.09	1470	0.97	<0.4	<2	<0.08	<0.8	7.1	4.6	<0.4	50.0
- HEPATOPANCREAS																			
MEAN(6)	11	19	0.35	3.02	3.3	1.1	608.2	743.0	0.09	658	6.9	2.4	3.2	0.28	1.2	13.5	5.9	1.2	88.2
S.D.	4	8	0.14	1.10	1.0	0.3	208.0	119.3	0.04	29	0.5	0.6	0.4	0.04	0.4	1.3	0.5	1.2	8.2
C.V.(%)	31	41	39	36	32	27	34	16	39	4	7	23	13	14	35	10	8	98	9
MAX.	17	32	0.50	4.70	5.0	1.5	910.0	898.0	0.15	700	7.7	2.9	<4	0.50	<2	15.1	6.7	3.7	102.0
MIN.	8	10	0.20	1.70	2.2	0.7	352.0	601.0	0.04	630	6.4	1.7	<3	<0.20	<1	11.3	5.3	<0.7	79.5

APPENDIX IIIB Tissue Trace Metal Concentrations - Descriptive Statistics - Vancouver Harbour, October 1985

Station	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	Ti	V	Zn
							Concentration (µg/g dry weight)												
CRAB																			
PACIFIC ENVIRONMENT INSTITUTE (PEI)																			
TANNER CRAB (Chionocetes bairdi) - MUSCLE																			
MEAN(2)	23	62	0.18	0.07	0.4	0.7	49.0	51.9	0.22	1880	1.03	0.4	2	0.23	0.8	14.0	7.5	0.4	112
S.D.	21	5	0.06	0	0	0.1	5.9	27.6	0.02	28	0.29	0	0	0.15	0	3.5	0.4	0	11
C.V.(%)	92	8	36	0	0	11	12	53	0.10	2	28	0	0	66	0	25	6	0	10
MAX.	38	65	0.22	0.07	<0.4	0.7	53.1	71.4	0.23	1900	1.23	<0.4	<2	0.33	<0.8	16.4	7.8	<0.4	119
MIN.	8	58	0.13	0.07	<0.4	0.6	44.8	32.4	0.20	1860	0.82	<0.4	<2	0.12	<0.8	11.5	7.2	<0.4	104
- HEPATOPANCREAS																			
MEAN(2)	33	44	0.40	8.70	1.0	0.6	351	1405	0.30	1050	4.38	2.2	2	0.33	0.8	19.8	9.5	0.7	105
S.D.	28	4	0.07	0	0.9	0.1	111	64	0.01	57	1.65	0.7	0	0.01	0	5.5	1.9	0.1	0
C.V.(%)	86	8	18	0	88	13	32	5	2	5	38	32	0	4	0	28	20	20	0
MAX.	53	46	0.45	8.70	1.7	0.6	429	1450	0.30	1090	6.00	2.7	<2	0.34	<0.8	23.7	10.8	0.8	105
MIN.	13	41	0.35	8.70	<0.4	0.5	272	1360	0.29	1010	3.67	1.7	<2	0.32	<0.8	15.9	8.1	0.6	105
- GILL																			
MEAN(2)	2585	52	11.70	17.7	13.4	9.8	325	10740	0.50	8410	58.2	2.6	4	25	1.4	110	127	19.1	154
S.D.	672	4	4.40	3.5	7.9	2.5	4	3055	0.06	1358	14.7	2.3	1.4	11	0.8	20	36	5.2	11
C.V.(%)	26	8	38	20	59	26	1	28	11	16	25	92	35	43	61	18	29	27	7
MAX.	3060	55	14.80	20.1	19.0	11.6	327	12900	0.54	9370	68.6	4.2	5	32	<2	124	152	22.8	162
MIN.	2110	49	8.59	15.2	7.8	8.0	322	8580	0.46	7450	47.8	0.9	3	17	<0.8	96	101	15.4	146
BURRARD YARROWS (BY)																			
DUNGENESS CRAB (Cancer magister) - MUSCLE																			
MEAN(6)	19	22	0.28	0.05	0.4	0.8	54.7	60.0	0.31	1720	1.28	0.4	2	0.18	1.0	36.03	8.2	0.4	181
S.D.	7	7	0.12	0.02	0	0.1	23.7	26.5	0.16	143	0.25	0.1	0	0.08	0.6	18.0	1.4	0	24
C.V.(%)	35	32	42	42	0	6	43	44	51	8	20	19	0	45	55	50	17	0	13
MAX.	29	31	0.45	0.09	<0.4	0.9	89.9	111.0	0.53	1990	1.52	0.6	<2	0.30	2.2	58.5	10.5	<0.4	210
MIN.	10	12	0.13	<0.04	<0.4	0.8	35.2	38.9	0.16	1590	0.92	<0.4	<2	<0.08	<0.8	15.3	7.2	<0.4	151

APPENDIX IIIB **Tissue Trace Metal Concentrations - Descriptive Statistics - Vancouver Harbour, October 1985**

Station	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	Ti	V	Zn
	Concentration (µg/g dry weight)																		
- HEPATOPANCREAS																			
MEAN(6)	5	19	0.59	3.1	1.3	0.9	221.0	205	0.25	1521	5.59	1.1	2.3	0.40	1.9	135.5	8.0	3.1	111
S.D.	1	5	0.31	1.9	0.5	0.3	92.0	62	0.10	467	1.37	0.6	0.5	0.19	1.7	135.1	0.8	3.6	37
C.V.(%)	17	24	53	60	39	31	42	30	40	31	24	51	22	47	90	1	10	116	33
MAX.	6	27	1.12	6.2	1.8	1.4	321.0	291	0.42	2000	7.49	1.7	3	0.64	4.5	346.0	9.0	9.8	153
MIN.	<4	14	0.18	0.6	0.6	0.6	31.6	102	0.17	793	4.19	0.5	<2	0.13	<0.8	14.8	7.0	<0.4	62.8
- GILL																			
MEAN(6)	521	16	7.00	0.6	7.8	4.1	254	4235	0.19	5580	12.6	3.7	2	37	0.9	177.3	35.62	7.62	220.00
S.D.	452	6	3.74	0.2	5.7	2.6	104	3507	0.04	554	8.6	5.0	0	26	0.2	36.0	20.31	5.88	66.04
C.V.(%)	9	4	53	33	7	6	4	8	2	1	68	136	0	71	19	2	6	8	3
MAX.	1420	28	14.0	0.8	13.9	8.6	431	11100	0.25	6370	29.8	13.7	<2	86	1.2	232.0	74.70	17.80	303.00
MIN.	200	11	2.66	0.3	1.1	1.5	144	1230	0.13	5050	6.7	<0.4	<2	8	<0.8	138.0	15.60	3.40	120.00
COAL HARBOUR (CH)																			
DUNGENESS CRAB (Cancer magister) - MUSCLE																			
MEAN(5)	15	19	0.23	0.04	0.4	0.8	75.9	52.1	0.37	1692	1.12	0.5	2	0.19	0.8	36.8	8.3	0.4	203
S.D.	11	3	0.18	0	0.1	0.1	16.9	13.8	0.20	529	0.23	0.2	0	0.08	0	41.7	1.0	0	23
C.V.(%)	71	15	77	0	20	15	22	27	53	31	21	34	0	41	0	113	12	0	11
MAX.	32	21	0.44	<0.04	0.6	0.9	99.8	68.6	0.66	2600	1.43	0.8	<2	0.32	<0.8	111.0	9.5	<0.4	233
MIN.	5	14	0.13	<0.04	<0.4	0.6	58.5	33.0	0.21	1310	0.87	<0.4	<2	0.13	<0.8	11.7	7.3	<0.4	181
- HEPATOPANCREAS																			
MEAN(5)	19	12	0.60	1.5	0.9	0.9	93.4	159	0.18	1654	6.64	0.7	2.2	0.38	1.0	197	11.5	0.9	78.1
S.D.	26	2	0.28	0.5	0.3	0.3	52.0	111	0.04	365	3.00	0.3	0.4	0.15	0.5	108	8.5	0.7	17.2
C.V.(%)	141	19	48	32	38	32	56	70	23	22	45	40	20	40	52	51	74	81	22
MAX.	65	16	0.99	1.9	1.3	1.4	171.0	323	0.23	2070	10.20	1.0	<3	0.60	<2.0	310	26.4	2.2	92.6
MIN.	<4	10	0.36	0.8	<0.4	<0.8	26.0	79	0.14	1320	3.40	<0.4	<2	0.20	<0.8	29	6.2	0.5	53.3

APPENDIX IIIB Tissue Trace Metal Concentrations - Descriptive Statistics - Vancouver Harbour, October 1985

	Concentration (µg/g dry weight)																		
Station	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	Ti	V	Zn
- GILL																			
MEAN(5)	564	12	6.18	0.4	6.6	3.2	320	3044	0.21	4474	12.7	0.7	2.4	29	0.8	148	44.1	6.0	213
S.D.	232	4	2.62	0.1	3.9	1.1	130	1751	0.03	984	4.3	0.4	0.5	20	0.9	48	13.6	2.6	73
C.V.(%)	41	30	42	25	59	34	41	58	13	22	33	61	23	68	106	33	31	44	34
MAX.	835	18	8.96	0.6	10.9	4.4	444	5040	0.23	6000	17.5	1.2	3	49	<1.0	218	56.7	8.1	324
MIN.	305	9	3.44	0.3	2.8	1.8	155	1150	0.17	3470	7.8	<0.4	<2	6	<0.8	93	24.1	2.5	143
STERLING (ST)																			
DUNGENESS CRAB (Cancer magister) - MUSCLE																			
MEAN(6)	18	28	0.23	0.05	0.4	0.7	58.5	59.5	0.58	1343	1.20	0.4	2	0.18	0.8	26.9	7.3	0.4	182
S.D.	12	6	0.08	0.01	0	0.1	14.9	29.0	0.27	98	0.29	0.1	0	0.06	0	7.5	0.7	0	19
C.V.(%)	64	23	36	22	0	13	25	49	47	7	24	19	0	33	0	28	10	0	11
MAX.	40	37	0.39	0.06	0.4	0.8	79.1	116.0	0.99	1480	1.53	0.6	<2	0.26	<0.8	36.2	8.1	<0.4	213
MIN.	8	21	0.15	<0.04	<0.4	0.6	39.4	31.2	0.32	1190	0.74	<0.4	<2	0.10	<0.8	18.2	6.4	<0.4	160
- HEPATOPANCREAS																			
MEAN(6)	11	21	0.44	2.0	0.9	0.8	94.0	134	0.28	1293	5.17	0.7	2.4	0.26	1.0	130.0	7.3	1.2	67.0
S.D.	8	5	0.18	1.3	0.5	0.2	66.5	54	0.13	158	0.95	0.4	0.5	0.14	0.5	95.7	0.8	1.3	21.4
C.V.(%)	70	26	42	67	58	18	71	40	46	12	18	56	23	55	49	74	12	107	32
MAX.	26	30	0.68	3.8	1.7	1.0	204.0	187	0.50	1460	6.50	1.4	<3	0.49	<2.0	236.0	8.4	3.7	94.9
MIN.	5	15	0.17	0.4	<0.4	0.6	25.4	67	0.14	1020	4.27	<0.4	<2	<0.08	<0.8	24.5	5.9	<0.4	47.6
- GILL																			
MEAN(6)	355	17	4.19	0.48	4.5	2.2	371	1781	0.33	4268	9.8	0.8	2	14	0.8	135	27.6	3.3	209
S.D.	156	4	1.70	0.11	2.5	0.9	77	891	0.09	728	3.2	0.8	0	10	0.04	31	10.9	1.2	38
C.V.(%)	44	24	41	23	55	40	21	50	27	17	33	90	0	68	5	23	40	37	18
MAX.	513	22	5.92	0.60	6.9	2.9	479	2880	0.48	4850	13.4	1.7	2	27	<0.9	196	38.0	5.2	252
MIN.	118	10	1.91	0.36	1.3	1.0	284	703	0.23	3020	4.5	<0.4	<2	2.7	<0.8	114	11.4	1.7	137

APPENDIX IIIB Tissue Trace Metal Concentrations - Descriptive Statistics - Vancouver Harbour, October 1985

Station	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	Ti	V	Zn
							Concentration (µg/g dry weight)												
PORT MOODY																			
DUNGENESS CRAB (Cancer magister) - MUSCLE																			
MEAN(6)	25	12	0.29	0.06	0.5	0.8	46.3	65.5	0.20	1915	1.28	0.5	2.4	0.18	1.0	55.8	7.6	0.5	180
S.D.	8	9	0.09	0.02	0.2	0.3	16.2	12.1	0.15	399	0.25	0.2	0.5	0.06	0.5	31.5	0.3	0.2	17
C.V.(%)	33	78	30	36	35	36	35	18	73	21	20	36	23	31	49	57	3	35	10
MAX.	38	25	0.40	0.08	<0.8	1.2	67.5	83.8	0.39	2370	1.60	0.7	<3	0.24	<2.0	108.0	8.1	<0.8	201
MIN.	13	<4	0.17	<0.04	<0.4	0.4	25.5	50.3	0.08	1430	0.83	<0.4	<2	<0.08	<0.8	12.7	7.4	<0.4	162
- HEPATOPANCREAS																			
MEAN(6)	34	16	0.95	2.3	0.8	1.1	95.9	183	0.23	4570	6.58	0.7	2	0.35	0.8	137	8.2	0.5	122
S.D.	27	6	0.30	0.5	0.2	0.3	119.9	31	0.13	3288	1.52	0.4	0	0.07	0	59	1.0	0.1	25
C.V.(%)	79	40	32	22	32	30	125	17	56	72	23	55	0	19	0	43	12	20	20
MAX.	81	23	1.30	3.1	0.9	1.5	273.0	217	0.47	8850	7.91	1.4	<2	0.45	<0.8	227	10.1	0.6	145
MIN.	14	9	0.57	1.7	<0.4	0.7	17.2	150	0.12	1480	4.15	<0.4	<2	0.28	<0.8	66	7.4	<0.4	86
- GILL																			
MEAN(6)	283	9	3.3	0.55	2.5	2.3	175	1358	0.17	4155	7.9	1.0	2.8	11.3	1.1	127	22.3	2.1	162
S.D.	265	4	3.2	0.21	2.9	1.5	102	1627	0.08	566	4.4	0.6	0.4	15.8	0.4	35	15.5	2.1	59
C.V.(%)	93	51	97	38	115	66	58	120	48	14	56	65	14	140	38	26	69	98	37
MAX.	700	16	8.3	0.80	8.2	4.4	334	3880	0.32	4780	15.1	2.2	<3	34	<2.0	194	48	5.3	235
MIN.	70	<7	1.1	0.22	<0.7	1.1	79.2	174	0.09	3430	4.2	<0.4	<2	<0.08	<0.8	90.4	9.4	<0.7	108
SOLE																			
PACIFIC ENVIRONMENT INSTITUTE (PEI)																			
ENGLISH SOLE (Parophrys vetulus) - MUSCLE																			
MEAN(6)	11	37	0.08	0.04	0.4	0.7	2.3	14.4	0.48	1305	0.52	0.4	2	0.08	0.8	2.13	0.6	0.4	20.4
S.D.	5	28	0	0	0.1	0.3	1.0	6.0	0.17	82	0.07	0.1	0	0	0	0.97	0.2	0	1.9
C.V.(%)	42	77	0	0	19	42	45	42	35	6	14	19	0	0	0	46	44	0	9
MAX.	18	93	<0.08	<0.04	0.6	1.3	3.7	24.6	0.69	1380	0.60	0.6	2	0.08	<0.8	3.89	0.8	<0.4	23.8
MIN.	<4	17	<0.08	<0.04	<0.4	0.5	1.1	9.2	0.28	1160	0.41	<0.4	<2	<0.08	<0.8	1.28	0.2	<0.4	18.8

APPENDIX IIIB Tissue Trace Metal Concentrations - Descriptive Statistics - Vancouver Harbour, October 1985

	Concentration (µg/g dry weight)																		
Station	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	Ti	V	Zn
- LIVER																			
MEAN(6)	13	32	0.08	2.5	4.7	0.8	64.1	1144	0.37	976	6.44	0.4	2	1.41	0.8	2.70	5.2	5.8	169.5
S.D.	4	21	0.01	1.6	2.5	0.2	25.5	516	0.18	301	2.77	0	0	1.78	0	1.05	4.1	8.6	55.7
C.V.(%)	33	67	10	74	62	53	27	40	45	50	31	0	0	25	0	39	79	148	33
MAX.	18	74	0.10	5.3	7.6	1.0	98.5	1660	0.65	1310	9.66	<0.4	<2	5.00	<0.8	4.61	9.8	21.1	228.0
MIN.	8	17	<0.08	1.0	1.2	0.5	29.4	388	0.15	453	2.15	<0.4	<2	0.45	<0.8	1.65	0.4	0.5	92.8
- GILL																			
MEAN(6)	490	5	2.48	0.04	0.8	1.5	4.6	239	0.13	1325	20.4	0.4	2	0.09	0.8	280	4.6	1.7	66.9
S.D.	344	1	0.95	0.01	0.2	0.3	1.2	41	0.04	100	4.0	0	0	0.02	0	23	1.9	1.6	4.1
C.V.(%)	70	19	38	19	26	20	26	17	28	8	20	0	0	23	0	8	40	97	6
MAX.	893	6	3.89	0.06	1.1	2.0	6.6	290	0.19	1460	25.9	<0.4	<2	0.13	<0.8	317	6.1	5.0	73.0
MIN.	56	<4	1.45	<0.04	0.5	1.2	3.3	177	0.09	1200	14.2	<0.4	<2	<0.08	<0.8	252	0.9	0.7	62.3
REX SOLE (Glyptocephalus zochirus) - MUSCLE																			
MEAN(2)	10	71	0.14	0.04	0.4	0.7	0.7	18.0	0.22	1215	1.84	0.4	2	0.10	0.8	11.68	0.6	0.4	16.8
S.D.	6	6	0.03	0	0	0.1	0.1	12.4	0.01	7	0.46	0	0	0.02	0	3.99	0.1	0	2.0
C.V.(%)	67	9	20	0	0	11	11	69	6	1	25	0	0	22	0	34	24	0	12
MAX.	14	75	0.16	<0.04	<0.4	0.7	0.7	26.7	0.23	1220	2.16	<0.4	<2	0.11	<0.8	14.50	0.7	<0.4	18.2
MIN.	5	66	0.12	<0.04	<0.4	0.6	0.6	9.2	0.21	1210	1.51	<0.4	<2	0.08	<0.8	8.86	0.5	<0.4	15.4
FLATHEAD SOLE (Hippoglossoides ellasodon) - MUSCLE																			
MEAN(3)	42	50	0.16	0.05	0.4	0.6	2.1	30.9	0.59	1490	1.37	0.4	2	0.14	0.8	7.95	0.9	0.4	18.5
S.D.	32	10	0.08	0.01	0	0.2	0.7	20.2	0.23	175	0.82	0	0	0.06	0	8.21	0.7	0	1.2
C.V.(%)	77	19	50	25	0	27	31	65	39	12	60	0	0	47	0	103	77	0	7
MAX.	79	59	0.22	0.06	<0.4	0.7	2.7	53.8	0.85	1670	1.95	<0.4	<2	0.21	<0.8	17.40	1.6	<0.4	19.3
MIN.	21	40	<0.08	<0.04	<0.4	<0.4	1.4	15.8	0.44	1320	0.79	<0.4	<2	0.09	<0.8	2.52	0.3	<0.4	17.1
- LIVER																			
MEAN(3)	13	19	0.10	1.0	1.8	1.3	26.9	353	0.16	492	3.72	0.4	2	0.11	0.8	1.86	3.3	0.4	99.9
S.D.	11	4	0.03	0.5	0.4	1.1	8.1	104	0.10	171	0.94	0	0	0.03	0	1.42	3.4	0	4.6
C.V.(%)	83	22	35	46	20	87	30	29	62	35	25	0	0	26	0	76	103	0	5

APPENDIX IIIB **Tissue Trace Metal Concentrations - Descriptive Statistics - Vancouver Harbour, October 1985**

Station	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	Ti	V	Zn
	Concentration (μg/g dry weight)																		
- LIVER (continued)																			
MAX.	26	22	0.14	1.4	2.2	2.5	36.1	445	0.23	677	4.61	<0.4	<2	0.13	<0.8	3.40	5.7	<0.4	103.0
MIN.	6	14	<0.08	0.5	1.5	0.4	20.7	241	0.09	341	2.73	<0.4	<2	0.09	<0.8	0.60	0.9	<0.4	94.6
- GILL																			
MEAN(3)	469	10	2.19	0.05	0.5	1.5	6.9	185	0.10	1607	13.5	0.4	2	0.12	0.8	275	2.2	0.4	80.8
S.D.	283	3	0.66	0.01	0.2	0.1	0.8	37	0.05	12	2.7	0	0	0.05	0	50	3.2	0	17.5
C.V.(%)	60	24	30	20	29	8	12	20	49	1	20	0	0	37	0	18	146	0	22
MAX.	784	13	2.78	0.06	0.7	1.6	7.4	211	0.15	1620	15.9	<0.4	<2	0.17	<0.8	331	5.9	0.4	101.0
MIN.	235	8	1.48	<0.04	<0.4	1.4	6.0	142	0.05	1600	10.6	<0.4	<2	<0.08	<0.8	234	<0.2	<0.4	70.4
DOVER SOLE (Microstomus pacifica) - MUSCLE																			
MEAN(6)	29	69	0.20	0.04	0.4	0.5	2.0	40.9	0.17	1292	1.19	0.4	2	0.09	0.8	7.12	2.3	0.4	19.2
S.D.	31	24	0.18	0	0.1	0.2	0.5	56.6	0.05	92	0.73	0	0	0.02	0	6.47	2.8	0	2.2
C.V.(%)	110	34	92	0	19	28	27	138	32	7	61	0	0	19	0	91	125	0	11
MAX.	89	107	0.48	<0.04	0.6	0.8	3.1	156.0	0.26	1390	2.66	<0.4	<2	0.12	<0.8	15.10	7.8	<0.4	22.8
MIN.	7	37	<0.08	<0.04	<0.4	0.4	1.6	11.9	0.12	1130	0.75	<0.4	<2	<0.08	<0.8	1.35	0.7	<0.4	16.9
- LIVER																			
MEAN(6)	27	7	0.15	2.0	2.3	0.7	17.7	646	0.23	704	3.87	0.4	2.2	3.64	0.8	3.45	5.7	0.4	98.6
S.D.	16	1	0.10	1.4	1.3	0.2	4.1	376	0.11	214	1.26	0.1	0.8	3.82	0.1	4.13	1.4	0.2	26.1
C.V.(%)	59	20	66	70	55	33	23	58	49	30	33	35	35	104.9	17	120	25	35	26
MAX.	51	9	0.30	4.4	3.9	1.1	23.8	1180	0.34	1020	5.50	<0.7	3	9.00	<1.0	11.80	6.6	0.5	141.0
MIN.	7	5	<0.06	0.6	1.0	<0.7	12.7	271	0.12	482	2.37	<0.3	<1	0.51	<0.6	0.96	3.6	<0.3	74.9
- GILL																			
MEAN(6)	467	5	2.22	0.06	1.7	1.6	10.5	473	0.07	1465	9.64	0.42	1.8	0.15	0.8	199	6.9	1.1	71.3
S.D.	725	1	0.42	0.03	0.8	0.5	10.1	204	0.02	157	3.39	0.04	0.4	0.07	0.1	33	3.5	0.5	9.9
C.V.(%)	155	20	19	46	47	29	96	43	22	11	35	10	22	50	12	17	50	44	14
MAX.	1920	6	2.76	0.10	2.8	2.4	29.5	748	0.08	1620	16.30	<0.5	<2	0.25	<1.0	247	13.2	1.8	84.1
MIN.	66	<4	1.70	<0.04	0.9	1.1	3.0	236	0.05	1260	6.76	<0.4	<1	<0.08	<0.7	155	2.8	0.5	58.1

APPENDIX IIIB Tissue Trace Metal Concentrations - Descriptive Statistics - Vancouver Harbour, October 1985

Station	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	Ti	V	Zn
	Concentration (µg/g dry weight)																		
BURRARD NARROWS (BN)																			
ENGLISH SOLE (Parophrys vetulus) - MUSCLE																			
MEAN(6)	7	52	0.20	0.04	0.04	0.6	1.2	21.2	0.19	1167	1.22	0.4	2	0.12	0.8	25.08	4.5	0.4	21.6
S.D.	4	17	0.21	0	0	0.1	0.7	5.0	0.11	135	1.14	0	0	0.04	0	35.60	1.9	0	6.5
C.V.(%)	61	32	102	10	0	24	58	24	58	12	94	0	0	35	0	141	42	0	30
MAX.	12	72	0.58	0.05	<0.04	0.8	2.4	28.5	0.32	1320	3.17	<0.4	<2	0.17	<0.8	86.10	5.7	<0.4	34.7
MIN.	<4	34	<0.08	<0.04	<0.04	<0.4	0.4	14.7	0.04	1020	0.46	<0.4	<2	<0.08	<0.8	1.58	0.7	<0.4	16.9
- LIVER																			
MEAN(6)	13	12	0.08	1.0	1.4	0.6	16.1	250.1	0.08	593	3.58	0.4	2.3	6	1.7	2.48	5.8	2.4	149
S.D.	5	5	0	0.5	0.6	0.1	3.8	106.7	0.04	154	0.51	0	0.8	1	1.3	0.58	0.4	2.5	38
C.V.(%)	36	48	0	51	42	19	24	42.7	52	26	14	0	35	18	78	23	7	104	25
MAX.	21	21	<0.08	2.0	2.2	0.7	22.8	367.0	0.14	896	4.52	<0.4	4	7	3.5	3.26	6.5	7.5	215
MIN.	7	5	<0.08	0.4	0.9	<0.4	11.8	97.5	0.04	478	3.04	<0.4	<2	4	<0.8	1.84	5.5	0.6	107
- GILL																			
MEAN(6)	77	5	1.43	0.06	0.6	1.3	4.5	307	0.05	1160	7.39	0.4	2	1.61	0.8	239	6.4	1.2	68.2
S.D.	15	2	0.19	0.03	0.3	0.2	0.8	42	0.02	73	0.95	0	0	1.86	0	24	0.7	0.4	4.8
C.V.(%)	19	33	13	51	45	15	18	14	33	6	13	0	0	116	0	10	12	30	7
MAX.	98	8	1.78	0.11	1.1	1.5	5.3	348	0.08	1300	8.81	<0.4	<2	4.00	<0.8	270	7.4	1.8	74.6
MIN.	53	<4	1.23	<0.04	<0.4	1.1	3.0	243	0.04	1100	6.36	<0.4	<2	0.32	<0.8	198	5.3	0.8	62.5
ROCK SOLE (Lepidosetta bilineata) - MUSCLE																			
MEAN(3)	6	34	0.08	0.04	0.4	0.5	0.7	9.5	0.10	1041	0.60	0.4	2	0.08	0.8	6.44	4.7	0.4	27.2
S.D.	1	7	0	0	0	0	0.2	1.4	0.04	88	0.16	0	0	0	0	4.23	0.7	0	8.6
C.V.(%)	10	20	0	0	0	0	23	14	42	8	27	0	0	0	0	66	15	0	31
MAX.	6	39	<0.08	<0.04	<0.4	0.5	0.8	10.9	0.14	1140	0.78	<0.4	<2	<0.08	<0.8	10.60	5.1	<0.4	35.9
MIN.	5	26	<0.08	<0.04	<0.4	0.5	0.5	8.2	0.06	973	0.48	<0.4	<2	<0.08	<0.8	2.14	3.9	<0.4	18.8

APPENDIX IIIB Tissue Trace Metal Concentrations - Descriptive Statistics - Vancouver Harbour, October 1985

Station	Concentration (µg/g dry weight)																	
	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	Ti	V	Zn
- LIVER																			
MEAN(3)	6	8	0.09	1.5	2.9	0.6	28.1	1168	-	553	3.47	-	2	2.78	1.2	1.72	4.0	3.5	124
S.D.	2	2	0.01	0.4	0.9	0.1	23.3	490	-	56	0.56	-	0	2.79	0.4	0.39	0.6	5.0	30
C.V.(%)	24	28	7	27	32	13	83	42	-	10	16	-	0	100	33	23	15	142	24
MAX.	8	11	<0.09	2.0	3.9	0.6	54.3	1720	-	586	4.10	<0.5	<2	6.00	1.6	2.16	4.6	9.3	159
MIN.	5	7	<0.08	1.2	2.2	<0.5	9.7	784	-	488	3.03	<0.4	<2	1.02	<0.8	1.41	3.4	<0.4	103
- GILL																			
MEAN(3)	56	4	1.54	0.04	0.5	1.9	3.3	202	0.07	1297	7.11	0.4	2	5	0.8	280	5.4	2.9	71.2
S.D.	66	1	0.43	0	0.1	0.2	2.0	108	0.01	51	0.89	0	0	1	0	25	2.1	3.5	5.3
C.V.(%)	118	13	28	0	12	8	62	54	11	4	13	0	0	22	0	9	39	122	7
MAX.	132	5	2.03	0.04	0.5	2.0	5.6	327	0.07	1340	8.13	<0.4	<2	6	<0.8	306	7.8	5.4	74.9
MIN.	17	<4	1.25	<0.04	<0.4	1.7	1.9	133	0.06	1240	6.48	<0.4	<2	4	<0.8	257	4.0	<0.4	67.4
COAL HARBOUR (CH)																			
ENGLISH SOLE (Parophrys vetulus) - MUSCLE																			
MEAN(6)	8	27	0.08	0.04	0.4	0.48	0.4	14.3	0.19	812	0.45	0.4	2	0.16	1.2	2.77	1.08	0.4	13.92
S.D.	3.2	9	0.01	0.01	0	0.16	0	4.6	0.02	73	0.18	0	0	0.05	0.5	2.75	0.97	0	2.38
C.V.(%)	42	35	10	19	0	33	0	32	12	9	41	0	0	30	42	99	90	0	17
MAX.	11	38	0.10	0.06	<0.4	0.80	<0.4	20.4	0.22	907	0.79	<0.4	<2	0.24	2.0	8.27	2.10	<0.4	17.10
MIN.	<4	12	<0.08	<0.04	<0.4	<0.40	<0.4	7.4	0.16	735	0.30	<0.4	<2	0.10	<0.8	0.85	<0.20	<0.4	11.00
- LIVER																			
MEAN(6)	6	12	0.11	1.32	1.67	0.9	18.7	402.7	0.17	447	2.39	0.9	2.2	4.03	2.0	2.70	1.5	2.17	116.9
S.D.	1	8	0.05	0.59	0.59	0.4	8.3	160.5	0.05	87	0.49	0.4	0.4	2.08	1.0	2.48	0.8	1.23	22.0
C.V.(%)	25	67	41	45	35	43	44	40	30	19	21	46	19	52	44	92	50	57	19
MAX.	<8	25	<0.20	2.20	2.40	1.5	29.1	569.0	0.25	506	2.80	1.3	<3	6.00	4.0	7.10	1.9	4.60	146.0
MIN.	<5	<4	<0.08	0.60	1.00	<0.4	6.7	232.0	0.11	276	1.46	<0.4	<2	0.55	<1.0	0.76	<0.2	1.30	85.6

APPENDIX IIIB Tissue Trace Metal Concentrations - Descriptive Statistics - Vancouver Harbour, October 1985

	Concentration (μg/g dry weight)																	
Station	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	Ti	V	Zn
- GILL																			
MEAN(6)	151	5	1.36	0.08	0.50	2.1	2.8	273.2	0.08	953	7.87	0.6	2.2	2.68	2.0	161	8.4	2.7	50.9
S.D.	57	1	0.22	0.05	0.20	0.5	0.6	72.0	0.02	105	1.74	0.2	0.4	2.21	0.5	29	2.4	0.5	8.2
C.V.(%)	37	19	16	67	40	22	22	26	26	11	22	29	19	83	24	18	28	20	16
MAX.	223	7	1.61	0.16	0.80	2.7	3.7	333.0	0.11	1050	9.84	0.8	3	5.00	2.3	193	12.7	3.6	62.1
MIN.	88	<4	1.08	<0.04	<0.40	1.4	2.3	173.0	0.06	791	5.62	<0.4	<2	0.58	1.0	123	5.5	2.0	37.0
STERLING (ST)																			
ENGLISH SOLE (Parophrys vetulus) - MUSCLE																			
MEAN(6)	12	70	0.18	0.05	0.50	0.9	1.3	25.4	0.30	1223	0.70	0.4	2	0.85	1.0	9.20	0.22	1.2	24.6
S.D.	7	26	0.09	0.01	0.20	0.3	0.4	16.9	0.09	159	0.35	0	0	1.55	0.4	8.91	0.04	0.9	4.4
C.V.(%)	61	37	51	28	40	34	32	66	31	13	50	0	0	182	36	97	19	76	18
MAX.	25	116	0.29	0.06	0.80	1.3	1.8	59.1	0.46	1370	1.42	<0.4	<2	4.00	1.7	26.40	0.30	2.4	29.7
MIN.	<4	43	<0.08	<0.04	<0.40	0.5	0.8	15.2	0.22	999	0.48	<0.4	<2	<0.08	<0.8	2.87	<0.20	<0.4	18.0
- LIVER																			
MEAN(6)	28	14	0.17	3.1	3.0	0.9	22.3	368	0.18	698	3.61	1.3	2.2	6.50	4.1	2.84	0.22	5.4	126
S.D.	18	6	0.05	1.3	1.7	0.2	8.0	382	0.04	82	0.42	0.4	0.4	3.67	2.1	1.07	0.04	3.2	13
C.V.(%)	65	44	32	42	55	24	36	104	24	12	12	29	19	57	51	38	19	59	10
MAX.	58	25	0.20	5.5	5.5	1.1	35.2	1130	0.25	810	4.30	1.7	<3	10.00	7.8	4.70	<0.3	10.5	142
MIN.	10	8	<0.09	1.9	1.2	<0.5	10.9	105	0.13	595	3.10	0.8	<2	<2.00	2.0	1.80	<0.2	1.8	107
- GILL																			
MEAN(6)	169	8	2.00	0.15	0.6	2.8	4.3	360.3	0.08	1337	9.70	0.8	2.2	6.00	2.4	318	9.5	4.5	71.2
S.D.	84	2	1.00	0.19	0.1	0.3	1.1	114.5	0.02	203	1.67	0.4	0.4	2.68	1.0	68	4.0	0.7	7.9
C.V.(%)	50	21	30	126	20	12	27	32	20	15	17	49	19	45	41	21	42	16	11
MAX.	276	11	3.12	0.50	0.7	3.1	5.4	458.0	0.10	1600	11.7	1.2	3	9.00	3.8	388	14.3	5.9	78.6
MIN.	61	6	1.42	<0.04	<0.4	2.2	2.3	190.0	0.06	1010	7.16	<0.4	<2	3.00	1.1	227	4.9	3.8	56.5
ROCK SOLE (Lepidopsetta bilineata) - MUSCLE																			
MEAN(6)	7	36	0.104	0.04	0.42	0.8	0.6	13.0	0.30	1417	0.55	0.6	3	0.11	0.8	4	0.2	0.5	20
S.D.	2	15	0.02	0	0.04	0.6	0.4	2.5	0.70	183	0.13	0.4	3	0.03	0	4	0	0.3	3

APPENDIX IIIB Tissue Trace Metal Concentrations - Descriptive Statistics - Vancouver Harbour, October 1985

Station	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	Ti	V	Zn
							Concentration (µg/g dry weight)												
- MUSCLE (continued)																			
C.V.(%)	37	40	22	0	10	77	77	19	22	13	23	67	98	26	0	103	0	53	12
MAX.	9	59	0.11	<0.04	0.5	2.1	1.5	16.3	0.39	1560	0.69	1.3	10	0.16	<0.8	11.2	<0.2	1.1	24.1
MIN.	<4	16	<0.08	<0.04	<0.4	<0.4	<0.4	9.9	0.20	1080	0.36	<0.4	<2	<0.08	<0.8	1.04	<0.2	<0.4	17.2
- LIVER																			
MEAN(6)	8	10	0.09	2.0	0.5	0.9	34.3	799	0.21	749	3.37	1.1	2	0.87	4.0	1.87	0.2	1.7	244
S.D.	4	3	0.01	1.0	0.2	0.2	15	289	0.06	184	0.99	0.5	0	0.35	2	1	0	1.1	122
C.V.(%)	48	30	11	47	31	27	44	36	27	25	29	42	0	40	41	42	0	66	50
MAX.	15	15	<0.10	2.4	0.8	1.2	62.7	1160	0.28	940	4.84	1.8	<2	1.40	6.0	3.20	<0.2	3.7	483
MIN.	<5	7	<0.08	0.7	<0.4	<0.4	20.2	400	0.14	497	1.94	<0.4	<2	0.37	1.0	0.90	<0.2	<0.4	127
- GILL																			
MEAN(6)	38	4	1.50	0.05	0.4	3.1	2.4	143.3	0.11	1603	6.38	0.8	2	5.67	2.7	323	2.9	2.8	81.9
S.D.	9	1	0.40	0.01	0	0.6	0.5	32.0	0.02	238	1.50	0.5	1	1.86	0.6	71	2.4	0.7	11.4
C.V.(%)	23	19	27	20	0	19	20	22	23	15	23	55	49	33	22	22	82	25	14
MAX.	53	6	2.05	0.06	<0.4	3.7	3.1	198.0	0.14	1910	7.87	1.7	5	9.00	3.6	417	5.6	4.0	92.0
MIN.	30	<4	1.08	<0.04	<0.4	2.3	1.7	108.0	0.08	1220	4.22	<0.4	<2	4.00	1.9	220	0.5	2.0	63.7
PORT MOODY (PM)																			
ENGLISH SOLE (Parophys vetulus) - MUSCLE																			
MEAN(6)	7	57	0.11	0.05	0.4	1.0	1.1	18.5	0.18	1100	0.45	0.42	2	0.10	0.8	3.93	0.2	0.9	23.6
S.D.	2	42	0.04	0.02	0	0.2	0.4	5.1	0.08	175	0.08	0.04	0	0.03	0	1.85	0	0.4	5.0
C.V.(%)	29	72	38	49	0	20	40	28	43	16	17	10	0	26	0	47	0	45	21
MAX.	10	139	0.18	0.10	<0.4	1.3	1.6	26.3	0.28	1330	0.55	0.5	<2	0.14	<0.8	6.47	<0.2	1.5	30.3
MIN.	4	24	<0.08	<0.04	<0.4	0.8	<0.4	12.9	0.08	849	0.32	<0.4	<2	<0.08	<0.8	1.76	<0.2	<0.4	19.2
- LIVER																			
MEAN(6)	32	12	0.12	2.2	3.8	1.0	16.3	639	0.12	607	2.97	1.2	2.2	3.02	1.7	2.41	0.4	4.5	99.7
S.D.	22	9	0.05	2.1	2.3	0.3	10.7	371	0.07	98	0.08	0.5	0.4	2.15	1.3	2.12	0.6	2.6	22.9
C.V.(%)	70	78	38	94	62	32	66	58	57	16	27	42	19	71	77	88	136	59	23

APPENDIX IIIB **Tissue Trace Metal Concentrations - Descriptive Statistics - Vancouver Harbour, October 1985**

	Concentration (µg/g dry weight)																		
Station	**Al**	**As**	**Ba**	**Cd**	**Co**	**Cr**	**Cu**	**Fe**	**Hg**	**Mg**	**Mn**	**Mo**	**Ni**	**Pb**	**Sn**	**Sr**	**Ti**	**V**	**Zn**
- LIVER (continued)																			
MAX.	70	30	0.19	6.3	7.8	1.6	31.1	1300	0.24	737	4.10	2.0	3	6.00	4.1	6.61	1.70	8.2	125.0
MIN.	11	<4	<0.08	0.9	1.2	0.6	4.8	213	0.05	515	2.09	0.6	<2	0.35	<0.8	0.99	<0.2	2.0	63.2
- GILL																			
MEAN(6)	332	9	2.69	0.13	0.7	3.3	3.8	591	0.07	1553	10.19	0.8	2	5.83	1.7	299	15.0	4.2	75.5
S.D.	228	3	0.99	0.18	0.4	0.7	0.7	230	0.03	177	2.60	0.5	0	1.83	0.8	82	6.9	0.9	5.2
C.V.(%)	69	39	37	138	54	21	19	39	39	11	26	61	0	31	48	27	46	22	7
MAX.	775	13	4.36	0.50	1.3	4.5	4.6	1050	0.11	1870	15.10	1.8	2	9.00	3.1	407	27.5	5.4	82.0
MIN.	117	5	1.59	<0.04	<0.4	2.6	2.8	410	0.04	1400	7.83	<0.4	<2	4.00	<0.8	190	7.6	3.0	68.4
OTHER FISH SPECIES																			
PACIFIC ENVIRONMENT INSTITUTE (PEI)																			
RATFISH (Hydrolagus colliei) - MUSCLE																			
VALUE	<4	61	<0.08	0.07	<0.4	0.6	1.6	12.1	0.65	1170	0.86	<0.4	<2	0.16	<0.8	0.6	6.9	<0.4	15.6
- LIVER																			
VALUE	<8	24	<0.2	0.68	1.3	<0.8	9.7	268	0.12	150	1.7	1.2	25	<3	<2	0.5	6.0	<0.8	16.6
- GILL																			
VALUE	29	22	0.4	0.14	0.8	0.7	4.2	123	0.3	907	7.93	0.5	<2	0.11	<0.8	20.3	6.8	<0.4	45.8
WALLEYE POLLOCK (Theragra chalcogramma) - MUSCLE																			
MEAN(3)	5	19	0.11	0.05	0.5	0.7	1.4	18.1	0.18	1340	1.25	0.4	2	0.15	0.8	7.40	6.3	0.4	15.3
S.D.	1	5	0.03	0.01	0.1	0.1	0.3	3.2	0.10	35	0.43	0	0	0.04	0	4.73	0.2	0	1.5
C.V.(%)	20	25	29	25	25	14	18	18	56	3	34	0	0	28	0	64	3	0	10
MAX.	6	24	0.14	0.06	0.6	0.8	1.7	21.1	0.30	1360	1.7	<0.4	<2	0.19	<0.8	10.60	6.5	<0.4	17.0
MIN.	<4	15	<0.08	<0.04	<0.4	0.6	1.2	14.7	0.11	1300	0.85	<0.4	<2	0.11	<0.8	1.96	6.1	<0.4	14.2

APPENDIX IIIB Tissue Trace Metal Concentrations - Descriptive Statistics - Vancouver Harbour, October 1985

Station	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	Ti	V	Zn
							Concentration (µg/g dry weight)												
						- LIVER													
MEAN(3)	5	-	0.09	0.38	0.6	0.5	14.0	90.5	0.05	196	3.64	0.5	2.3	0.23	0.9	1.61	8.4	0.5	42.7
S.D.	2	-	0.01	0.05	0.2	0.2	17.1	46.1	0.01	125	2.39	0.2	0.6	0.15	0.1	1.87	3.0	0.2	24.5
C.V.(%)	35	-	13	13	29	35	122	51	22	63	66	29	25	64	13	117	36	35	57
MAX.	<7	9	<0.1	0.43	0.7	<0.7	33.7	127.0	0.06	340	6.16	<0.7	<3	0.40	<1.0	2.93	11.9	<0.7	68.5
MIN.	<4	<7	<0.08	0.33	<0.4	<0.4	3.5	38.7	0.04	120	1.40	<0.4	<2	0.13	<0.8	0.28	6.6	<0.4	19.8
						- GILL													
MEAN(3)	117	5	1.54	0.10	0.8	1.2	4.0	270	0.07	1277	18.37	0.6	2	0.14	0.8	146	7.0	0.5	65.3
S.D.	36	1	0.33	0.03	0.5	0.2	2.3	35	0.05	76	9.55	0.3	0	0.04	0	38	1.5	0.1	9.9
C.V.(%)	31	22	21	28	62	12	56	13	65	6	52	51	0	28	0	26	21	12	15
MAX.	154	6	1.91	0.12	1.4	1.4	6.6	309	0.11	1330	27.30	0.9	2	0.18	<0.8	189	8.7	0.5	74.7
MIN.	83	<4	1.30	0.08	0.4	1.1	2.4	243	0.02	1190	8.30	<0.4	<2	0.11	<0.8	118	5.8	<0.4	54.9
PACIFIC COD (Gadus macrocephalus) - MUSCLE																			
VALUE	<4	30	<0.08	<0.04	<0.4	0.5	0.9	7.9	0.71	1260	0.32	<0.4	2	<0.08	<0.8	0.71	6.7	<0.4	15.6
					- LIVER														
VALUE	<4	11	<0.08	0.17	0.6	0.4	4.3	97.8	0.12	166	2.86	0.9	17	0.26	<0.8	0.96	6.2	<0.4	42.9
					- GILL														
VALUE	55	5	0.43	0.11	0.9	0.6	3.8	238	0.06	745	7.79	<0.4	<2	0.14	<0.8	21.1	7.5	<0.4	52.8
SPINY DOGFISH (Squalus acanthias) - MUSCLE																			
VALUE	<4	15	<0.08	0.06	<0.4	0.5	2	8.9	5.12	452	0.23	<0.4	2	0.13	<0.8	0.33	6.3	<0.4	6.7
					- LIVER														
VALUE	12	10	<0.08	3.00	0.6	<0.4	4.9	175	7.02	146	1.47	1.5	<2	0.16	<0.8	0.34	4.6	<0.4	17.5
					- GILL														
VALUE	19	9	1.05	0.15	0.5	0.9	2.8	94.8	3.94	872	4.6	<0.4	<2	0.22	<0.8	58.2	7.0	<0.4	48.6

APPENDIX IIIC **Tissue Trace Metal Concentrations - Descriptive Statistics - Vancouver Harbour, January 1986**

Station	Concentration (µg/g dry weight)																	
	Al	**As**	**Ba**	**Cd**	**Co**	**Cr**	**Cu**	**Fe**	**Hg**	**Mg**	**Mn**	**Mo**	**Ni**	**Pb**	**Sn**	**Sr**	**Ti**	**V**	**Zn**
PACIFIC ENVIRONMENT INSTITUTE (PEI)																			
SIDESTRIPE SHRIMP (Pandalopsis dispar) - MUSCLE																			
Mean(12)	88	41	0.37	0.11	0.4	1.2	16.7	198.0	0.18	1603	3.32	0.4	3	0.56	0.8	14.7	3.1	0.4	49.5
S.D.	26	4	0.11	0.02	0	0.5	2.9	47.8	0.06	79	0.71	0	2	0.17	0	4.8	0.8	0.1	2.6
C.V.(%)	30	10	29	16	0	42	17	24	35	5	21	0	56	31	0	32	26	14	5
MAX.	129	48	0.56	0.14	<0.4	2.4	23.4	271.0	0.24	1740	4.31	<0.4	8	0.89	<0.8	23.7	4.4	0.6	55.0
MIN.	52	36	0.21	0.08	<0.4	0.7	13.2	138.0	0.04	1500	2.38	<0.4	<2	0.25	<0.8	9.5	2.1	<0.4	45.4
- HEPATOPANCREAS																			
MEAN(6)	118	51	0.68	31.20	0.4	0.8	1261.7	311.8	-	787	14.70	0.4	2	0.47	0.8	19.4	2.8	0.9	96.2
S.D.	82	7	0.24	3.68	0.1	0.2	224.1	175.3	-	168	3.44	0.1	0	0.35	0.1	5.3	1.3	0.4	12.7
C.V.(%)	70	14	36	12	18	29	18	56	-	21	23	24	0	75	18	27	48	40	13
MAX.	271	64	1.10	35.40	0.5	1.2	1650.0	650.0	-	1030	20.60	0.6	2	1.10	<1.0	28.0	5.1	1.5	114.0
MIN.	43	44	0.43	24.50	<0.4	0.6	1030.0	153.0	-	562	11.10	<0.3	2	<0.08	<0.6	11.9	1.4	0.5	82.0
CENTRE (CT)																			
COONSTRIPE SHRIMP (Pandalus danae) - MUSCLE																			
MEAN(6)	15	22	0.10	0.09	0.4	0.5	26.8	30.9	0.15	1537	1.13	0.4	2	0.36	0.8	14.0	0.8	0.4	60.2
S.D.	5	3	0.03	0.01	0	0.1	4.9	8.2	0.04	50	0.14	0.1	0.4	0.18	0	3.7	0.1	0	3.9
C.V.(%)	32	13	28	12	0	26	18	26	23	3	12	19	19	50	0	27	18	0	6
MAX.	21	25	0.14	0.10	<0.4	0.8	34.1	39.0	0.20	1630	1.34	0.6	3	0.68	<0.8	20.1	1.0	<0.4	65.0
MIN.	8	17	<0.08	0.07	<0.4	<0.4	19.6	18.4	0.10	1480	1.02	<0.4	<2	0.17	<0.8	9.5	0.6	<0.4	55.0
- HEPATOPANCREAS																			
MEAN(3)	14	13	0.20	2.73	0.4	0.4	314.3	220.7	-	605	5.73	0.4	2	0.54	0.8	25.2	1.0	0.5	78.0
S.D.	1	3	0.12	1	0	0	26	90	-	62	1	0.1	1	0.21	0	21	0.4	0.1	11
C.V.(%)	4	20	60	32	0	0	8	41	-	10	17	16	35	39	6	84	40	25	14
MAX.	14	15	0.34	3.70	<0.4	0.4	343.0	325.0	0.08	655	6.62	0.6	<2	0.67	<0.8	49.6	1.5	0.6	90.2
MIN.	13	10	0.13	2.00	<0.4	<0.4	292.0	164.0	0.08	535	4.68	<0.4	<1	0.30	<0.7	11.7	0.7	<0.4	70.8

APPENDIX IIIC Tissue Trace Metal Concentrations - Descriptive Statistics - Vancouver Harbour, January 1986

Station	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	Ti	V	Zn
	Concentration (µg/g dry weight)																		
HUMPBACK SHRIMP (*Pandalus hypsinotus*) - MUSCLE																			
MEAN(6)	15	14	0.12	0.11	0.4	0.4	29.5	161.0	0.18	1682	1.84	0.4	2	0.36	0.8	13.4	0.9	0.4	60.9
S.D.	10	4	0.04	0.06	0	0	4.2	304.3	0.03	81	1.68	0	0	0.32	0	2.5	0.7	0	16.4
C.V. (%)	66	27	35	53	0	10	14	189	17	5	92	0	0	88	0	19	73	0	27
MAX.	30	19	0.17	0.20	<0.4	0.5	37.3	781.0	0.20	1760	5.26	<0.4	<2	0.85	<0.8	16.8	2.2	<0.4	93.8
MIN.	7	8	<0.08	<0.04	<0.4	<0.4	25.1	18.7	0.13	1560	0.96	<0.4	<2	0.08	<0.8	10.5	0.5	<0.4	51.2
- HEPATOPANCREAS																			
MEAN(3)	18	20	0.73	8.87	0.4	0.5	745.0	516.3	-	950	7.45	0.4	2	0.65	0.8	69.4	1.1	1.2	83.4
S.D.	2	2	0.42	0.96	0.1	0.1	154.2	54.2	-	361	0.85	0.1	1	0.54	0.1	93.2	0.8	0.9	15.3
C.V. (%)	13	8	58	11	13	12	21	11	-	38	11	13	35	83	15	134	79	69	18
MAX.	19	22	1.22	9.90	0.5	0.5	835.0	578.0	-	1360	8.18	<0.5	<2	1.26	<0.9	177.0	1.6	2.2	93.8
MIN.	15	19	0.47	8.00	<0.4	<0.4	567.0	476.0	-	681	6.51	<0.4	<1	0.24	<0.7	15.1	<0.1	0.6	65.8
PORT MOODY (PM)																			
COONSTRIPE SHRIMP (Pandalus danae) - MUSCLE																			
MEAN(12)	60	16	0.29	0.08	0.4	0.7	30.4	128.5	0.21	1679	2.31	0.4	2	0.59	0.8	20.4	2.5	0.4	59.5
S.D.	25	3	0.11	0.05	0	0.2	5.4	53.2	0.06	65	0.62	0	0.4	0.21	0	17.2	1.0	0	6.5
C.V.(%)	42	16	37	62	0	23	18	41	27	4	27	0	18	36	0	84	40	0	11
MAX.	117	20	0.47	0.22	<0.4	1.0	37.8	236.0	0.31	1800	3.23	<0.4	3	1.03	<0.8	72.3	4.8	<0.4	72.6
MIN.	37	11	0.18	<0.04	<0.4	0.5	18.1	69.0	0.12	1560	1.47	<0.4	<2	0.26	<0.8	9.9	1.5	<0.4	52.1
- HEPATOPANCREAS																			
MEAN(3)	36	26	0.48	4.47	0.4	0.7	714.0	495.0	-	945	5.75	0.4	1	0.95	0.8	51.2	1.5	0.7	88.5
S.D.	19	4	0.25	1.01	0	0.2	540.0	241.4	-	389	0.17	0	1	0.81	0.1	33.5	0.6	0.3	18.4
C.V. (%)	53	13	52	23	0	25	76	49	-	41	3	0	43	85	12	65	44	44	21
MAX.	58	30	0.67	5.40	<0.4	0.8	1330.0	767.0	-	1350	5.93	<0.4	<2	1.72	<0.9	70.9	2.2	1.1	109.0
MIN.	24	23	0.20	3.40	<0.4	0.5	322.0	306.0	-	574	5.61	<0.4	<1	0.11	<0.7	12.6	1.0	0.5	73.5

APPENDIX IIIC **Tissue Trace Metal Concentrations - Descriptive Statistics - Vancouver Harbour, January 1986**

	Concentration (µg/g dry weight)																	
Station	**Al**	**As**	**Ba**	**Cd**	**Co**	**Cr**	**Cu**	**Fe**	**Hg**	**Mg**	**Mn**	**Mo**	**Ni**	**Pb**	**Sn**	**Sr**	**Ti**	**V**	**Zn**
COAL HARBOUR (CH)																			
DUNGENESS CRAB (Cancer magister) - MUSCLE																			
MEAN(6)	29	13	0.33	0.06	0.4	0.8	65.5	115.3	0.539	1640	1.97	0.4	2	0.49	0.8	46.9	1.4	0.4	214
S.D.	8	2	0.13	0.02	0.1	0.2	31.6	70.1	0.182	188	0.64	0	0	0.51	0	26.1	0.3	0	35
C.V.(%)	29	19	38	38	27	22	48	61	34	11	32	0	0	103	0	56	22	0	16
MAX.	38	16	0.50	0.09	0.7	1.1	125.0	234.0	0.782	1850	2.87	<0.4	<2	1.28	<0.8	93.0	1.8	<0.4	266
MIN.	16	9	0.22	<0.04	<0.4	0.6	35.9	60.6	0.365	1390	1.28	<0.4	<2	<0.08	<0.8	16.6	1.0	<0.4	185
- HEPATOPANCREAS																			
MEAN(6)	26	23	0.69	2.4	0.8	1.1	108.0	242	0.319	2842	6.59	0.6	2.2	0.67	0.8	186.0	1.2	0.6	90.6
S.D.	15	19	0.16	1.8	0.4	0.2	45.9	85	0.251	1799	1.90	0.2	0.4	0.08	0	152.4	0.8	0.3	39.1
C.V.(%)	57	81	23	78	56	16	43	35	79	63	29	40	19	13	0	82	68	52	43
MAX.	39	60	0.86	5.9	1.5	1.4	175.0	365	0.643	6330	8.72	0.9	3	0.80	<0.8	386.0	2.0	1.1	162.0
MIN.	8	10	0.40	0.9	<0.4	0.9	35.5	116	0.065	1230	3.85	<0.4	<2	0.57	<0.8	23.1	<0.2	<0.4	52.2
- GILL																			
MEAN(6)	399	8	4.85	0.48	2.1	2.1	280	1802	0.15	4603	12.75	0.4	2	16.96	0.8	155.3	15.7	2.8	182
S.D.	249	2	2.12	0.08	0.7	0.9	91	1229	0.04	783	6.19	0	1	15.98	0	74.9	8.9	1.9	50
C.V.(%)	62	21	44	17	34	44	32	68	27	17	49	0	33	94	0	48	57	67	27
MAX.	786	10	7.81	0.60	3.0	3.5	426	3780	0.20	5550	20.70	<0.4	4	42.00	<0.8	277.0	28.7	6.0	258
MIN.	165	5	2.01	0.35	1.3	1.1	166	468	0.10	3320	6.28	<0.4	<2	1.55	<0.8	89.0	6.4	0.9	103
BURRARD NARROWS (BY)																			
DUNGENESS CRAB (Cancer magister) - MUSCLE																			
MEAN(6)	18	19	0.22	0.06	0.4	0.6	64.5	47.6	0.573	1785	1.27	0.4	2	0.20	0.8	58.7	0.8	0.4	217
S.D.	5	6	0.17	0.03	0	0.1	34.6	11.7	0.219	385	0.18	0	0	0.13	0	36.0	0.4	0	55
C.V.(%)	26	30	76	45	0	15	54	25	38	22	14	0	0	66	0	61	43	0	26
MAX.	26	30	0.56	0.10	<0.4	0.7	122.0	65.9	0.789	2440	1.55	<0.4	<2	0.44	<0.8	131.0	1.4	<0.4	291
MIN.	12	15	0.13	<0.04	<0.4	0.5	32.9	32.9	0.351	1380	1.06	<0.4	<2	<0.08	<0.8	34.7	0.3	<0.4	163

APPENDIX IIIC Tissue Trace Metal Concentrations - Descriptive Statistics - Vancouver Harbour, January 1986

Station	Concentration (μg/g dry weight)																		
	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	Ti	V	Zn
- HEPATOPANCREAS																			
MEAN(6)	16	17	0.55	1.6	0.6	0.8	128.7	178.4	0.383	3424	4.70	0.5	2	1.01	0.8	57.8	1.0	1.6	79.8
S.D.	9	4	0.45	1.0	0.4	0.4	97.9	105.6	0.064	2549	1.16	0.2	0	1.96	0	45.5	0.3	2.1	20.8
C.V.(%)	58	25	81	59	65	47	76	59	17	74	25	46	0	1.94	0	79	31	131	26
MAX.	26	25	1.41	3.0	1.4	1.3	285.0	370.0	0.500	7950	6.73	1.0	2	5.00	<0.8	145.0	1.4	5.9	109.0
MIN.	6	13	0.16	0.6	<0.4	<0.4	38.3	79.8	0.310	756	3.47	<0.4	<2	<0.08	<0.8	20.8	0.6	<0.4	48.0
- GILL																			
MEAN(6)	156	9	1.55	0.4	0.5	1.1	232	534	0.34	4337	5.82	0.4	2	3.90	0.8	114.8	5.9	1.0	134.0
S.D.	118	1	0.71	0.1	0.1	0.4	36	325	0.08	307	1.82	0	0	3.23	0	32.4	3.0	0.6	33
C.V.(%)	76	13	46	20	17	33	16	61	24	7	31	0	0	83	0	28	52	58	24
MAX.	380	11	2.33	0.5	0.6	1.7	272	1060	0.42	4850	8.35	<0.4	<2	8.00	<0.8	180.0	10.3	2.1	190
MIN.	72	8	0.67	0.3	<0.4	0.6	167	180	0.20	3990	4.07	<0.4	<2	0.63	<0.8	95.2	3.0	<0.4	109
CENTRE (CT)																			
DUNGENESS CRAB (Cancer magister) - MUSCLE																			
MEAN(6)	16	19	0.19	0.06	0.4	0.6	57.8	38.7	0.561	1927	1.16	0.4	2	0.74	0.8	49.8	0.8	0.4	204
S.D.	6	4	0.08	0.03	0.1	0.2	13.0	9.8	0.286	160	0.12	0	0	0.04	0	22.8	0.3	0	44
C.V.(%)	37	22	43	49	19	27	22	25	51	8	10	0	0	5	0	46	39	0	21
MAX.	26	25	0.30	0.10	0.6	0.8	81.6	49.1	0.951	2110	1.28	<0.4	<2	0.78	<0.8	89.7	1.0	<0.4	270
MIN.	9	13	0.09	<0.04	<0.4	<0.4	46.0	23.1	0.270	1690	0.96	<0.4	<2	0.68	<0.8	32.9	0.2	<0.4	145
- HEPATOPANCREAS																			
MEAN(6)	47	26	0.74	1.4	1.2	0.8	249.4	230	0.247	6030	5.48	0.4	2.2	1.48	0.8	86.1	2.2	0.8	85.0
S.D.	36	10	0.15	0.5	0.6	0.1	123.8	87	0.215	3199	0.87	0	0.4	1.30	0	33.3	1.4	0.3	35.0
C.V.(%)	77	37	21	37	51	16	50	38	87	53	16	0	19	88	0	39	63	34	41
MAX.	89	38	0.90	2.3	2.2	1.0	414.0	324	0.684	10500	6.40	<0.4	3	4.00	<0.8	130.0	3.6	1.1	140.0
MIN.	6	11	0.47	0.7	<0.4	0.7	45.3	111	0.130	2830	4.57	<0.4	<2	0.41	<0.8	38.0	0.5	0.5	41.3
- GILL																			
MEAN(6)	175	9	1.36	0.6	1.4	0.9	222	496	0.090	5662	6.37	0.4	2	3.39	0.8	118.9	6.5	1.2	108.9
S.D.	72	3	0.55	0.1	0.4	0.2	28	217	0.014	720	1.24	0	0	1.74	0	22.5	2.9	0.4	27.6

APPENDIX IIIC Tissue Trace Metal Concentrations - Descriptive Statistics - Vancouver Harbour, January 1986

Station	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	Ti	V	Zn
	Concentration (µg/g dry weight)																		
- GILL (continued)																			
C.V.(%)	41	32	40	23	32	23	13	44	16	13	19	0	0	51	0	19	45	34	25
MAX.	265	14	1.99	0.8	2.2	1.3	245	813	0.110	6720	8.23	<0.4	<2	6.00	<0.8	147.0	10.5	2.0	140.0
MIN.	66	6	0.42	0.5	1.0	0.7	172	146	0.071	4720	5.29	<0.4	<2	1.42	<0.8	78.6	2.3	0.9	74.2
PORT MOODY (PM)																			
DUNGENESS CRAB (*Cancer magister*) - MUSCLE																			
MEAN(5)	17	18	0.22	0.06	0.4	0.5	48.9	59.9	0.522	1650	1.20	0.4	2	0.64	0.8	43.3	1.0	0.4	233
S.D.	10	4	0.16	0.01	0	0.1	19.4	22.5	0.330	214	0.45	0	0	0.10	0	28.6	0.5	0	32
C.V.(%)	59	22	74	10	0	29	40	37	63	13	38	0	0	15	0	66	53	0	14
MAX.	33	23	0.50	0.06	<0.4	0.7	75.1	98.2	0.938	1920	1.98	<0.4	<2	0.77	<0.8	83.1	1.8	<0.4	277
MIN.	8	14	0.10	0.05	<0.4	0.4	24.2	43.3	0.120	1440	0.85	<0.4	<2	0.54	<0.8	10.5	0.4	<0.4	202
- HEPATOPANCREAS																			
MEAN(5)	19	17	0.64	1.3	0.6	1.2	130.6	196	0.19	3930	7.70	0.5	2	0.69	0.8	154.8	1.0	0.4	98
S.D.	10	4	0.34	0.6	0.3	0.6	75.0	71	0.09	1356	5.02	0.1	0	0.42	0	152.0	0.2	0.1	35
C.V.(%)	52	23	53	43	57	51	57	36	50	35	65	27	0	62	0	98	23	20	36
MAX.	28	21	1.05	1.7	1.2	2.2	243.0	312	0.32	5350	16.00	0.7	2	1.25	<0.8	391.0	1.4	0.6	144
MIN.	<4	11	0.27	0.6	<0.4	0.7	37.0	127	0.10	2410	3.20	<0.4	<2	<0.08	<0.8	33.7	0.8	<0.4	52
- GILL																			
MEAN(5)	569	11	6.30	0.57	1.8	3.5	264	2881	0.223	5242	13.84	0.4	3	30	0.8	161.8	20.1	4.1	223
S.D.	382	4	3.32	0.21	0.9	1.9	57	1850	0.193	609	7.06	0	1	20	0	30.8	12.3	2.7	39
C.V.(%)	67	34	53	38	47	55	22	64	87	12	51	0	21	67	0	19	61	67	18
MAX.	1070	16	10.50	0.80	3.1	6.2	341	5640	0.550	5930	22.90	<0.4	3	61	<0.8	204.0	38.0	7.9	279
MIN.	170	6	1.68	0.24	0.7	1.1	212	576	0.067	4390	5.49	<0.4	2	5	<0.8	129.0	6.8	0.7	187
IOCO																			
DUNGENESS CRAB (*Cancer magister*) - MUSCLE																			
MEAN(5)	31	15	1.00	0.04	0.4	0.6	29.0	103.2	0.247	1858	1.82	0.4	2	0.60	0.8	206.2	1.1	0.4	180
S.D.	18	5	0.63	0	0	0.1	7.7	85.4	0.309	378	0.78	0	0	0.03	0	138.4	0.6	0	34

APPENDIX IIIC Tissue Trace Metal Concentrations - Descriptive Statistics - Vancouver Harbour, January 1986

Station	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	Ti	V	Zn
	Concentration (µg/g dry weight)																		
- MUSCLE (continued)																			
C.V.(%)	59	32	64	0	0	18	27	83	125	83	43	0	0	5	0	67	56	0	19
MAX.	62	23	1.69	<0.04	<0.4	0.8	39.1	256.0	0.795	2230	3.03	<0.4	<2	0.63	<0.8	365.0	2.1	<0.4	232
MIN.	17	10	0.16	<0.04	<0.4	0.5	22.0	63.8	0.056	1310	0.97	<0.4	<2	0.56	<0.8	17.1	0.6	<0.4	143
- HEPATOPANCREAS																			
MEAN(5)	20	19	0.79	1.3	0.7	1.0	83.2	215	0.127	3000	7.65	0.7	2	0.72	0.8	161.5	1.1	0.7	85.6
S.D.	10	3	0.21	0.4	0.2	0.5	58.7	18	0.031	824	2.73	0.2	0	0.10	0	95.2	0.3	0.3	13.1
C.V.(%)	51	17	27	31	25	47	71	8	24	27	36	32	0	14	0	59	30	41	15
MAX.	32	22	1.09	1.8	0.8	1.9	187.0	229	0.150	3670	12.10	1.1	<2	0.87	<0.8	325.0	1.5	1.1	102.0
MIN.	9	14	0.57	0.9	<0.4	0.7	50.5	185	0.077	1850	5.03	0.5	<2	0.63	<0.8	78.4	0.7	0.4	65.8
- Gill																			
MEAN(5)	1060	15	8.84	1.0	4.1	7.4	278	6002	0.264	4320	21.90	0.4	2	49	0.8	169	36.4	9.7	243
S.D.	593	6	2.45	0.4	1.6	2.6	40	2382	0.106	978	11.03	0	1	14	0	18	13.8	4.0	26
C.V.(%)	56	39	28	37	41	36	14	40	40	23	50	0	37	27	0	11	38	41	11
MAX.	1990	25	12.10	1.6	6.3	11.5	328	9620	0.370	5630	39.20	<0.4	4	66	<0.8	195	57.8	15.9	287
MIN.	525	10	5.90	0.7	1.9	4.2	231	3540	0.110	3530	11.80	<0.4	<2	36	<0.8	147	21.6	6.2	225
SOLE																			
PACIFIC ENVIRONMENT INSTITUTE (PEI)																			
ENGLISH SOLE (Parophrys vetulus) - MUSCLE																			
MEAN(6)	25	27	0.13	0.04	0.4	0.8	1.0	50.8	0.504	1250	0.81	0.4	2.2	0.08	0.8	2.01	1.05	0.4	18.23
S.D.	19	13	0.09	0	0	0.1	0.3	33.1	0.207	113	0.42	0	0.4	0	0	1.07	0.79	0	1.43
C.V.(%)	75	48	67	0	0	15	28	65	41	9	52	0	19	0	0	53	75	0	8
MAX.	61	46	0.31	<0.04	<0.4	0.9	1.4	113.0	0.789	1470	1.61	<0.4	3	<0.08	<0.8	3.56	2.40	<0.4	20.20
MIN.	9	17	<0.08	<0.04	<0.4	0.6	0.7	21.9	0.310	1140	0.44	<0.4	<2	<0.08	<0.8	0.95	0.20	<0.4	15.80

APPENDIX IIIC Tissue Trace Metal Concentrations - Descriptive Statistics - Vancouver Harbour, January 1986

	Concentration (µg/g dry weight)																	
Station	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	Ti	V	Zn
					- LIVER														
MEAN(6)	19	30	0.09	1.5	0.8	0.8	56.2	919	0.356	918	4.85	0.4	2.2	0.70	0.8	2.41	1.0	1.9	142
S.D.	9	14	0.02	1.0	0.7	0.3	23.1	544	0.036	310	1.77	0	0.4	0.63	0	0.62	0.4	1.1	33
C.V.(%)	46	45	19	64	96	35	41	59	10	34	37	0	19	90	0	26	40	60	23
MAX.	30	53	0.12	2.8	2.2	1.1	96.8	1950	0.410	1340	6.65	<0.4	3	1.86	<0.8	3.59	1.4	3.5	185
MIN.	9	13	<0.08	0.4	<0.4	0.5	35.3	468	0.310	502	2.36	<0.4	<2	0.20	<0.8	1.86	0.4	1.1	106
					- GILL														
MEAN(6)	385	6	3.34	0.08	0.4	2.4	7.3	825	0.422	1445	23.82	0.4	4	0.77	0.8	258	10.3	2.1	69.8
S.D.	333	3	1.57	0.03	0	0.8	4.7	603	0.217	250	8.35	0	1	1.59	0	51	8.7	0.9	5.2
C.V.(%)	87	47	47	32	0	35	64	73	51	17	35	0	33	207	0	20	85	45	7
MAX.	920	8	5.72	0.11	<0.4	3.6	14.7	1790	0.781	1880	33.60	<0.4	6	4.00	<0.8	318	23.9	3.7	78.9
MIN.	96	<4	1.23	<0.04	<0.4	1.5	3.3	261	0.120	1210	14.20	<0.4	3	<0.08	<0.8	193	2.3	1.2	64.4
CENTRE (CT)																			
ENGLISH SOLE (Parophys vetulus) - MUSCLE																			
MEAN(6)	7	53	0.10	0.28	0.7	0.8	4.6	115.6	0.245	1169	1.70	0.4	2	1.57	0.8	7.87	0.3	1.0	39.8
S.D.	5	24	0.04	0.60	0.7	0.5	6.5	238.8	0.099	137	2.64	0	0	3.64	0	11.27	0.2	1.4	47.1
C.V.(%)	67	44	39	210	102	57	143	207	40	12	156	0	0	231	0	143	67	144	118
MAX.	17	92	0.17	1.5	2.1	1.7	16.5	603.0	0.350	1300	7.04	<0.4	<2	9.00	<0.8	30.80	0.7	3.8	136.0
MIN.	4	24	<0.08	<0.04	<0.4	0.4	0.4	12.8	0.090	931	0.34	<0.4	<2	<0.08	<0.8	1.82	<0.2	<0.4	18.3
					- LIVER														
MEAN(6)	11	26	0.08	1.0	0.6	1.0	21.3	280.1	0.248	986	4.99	0.4	2	3.14	0.8	2.66	0.3	0.9	171.5
S.D.	5	19	0.01	0.8	0.2	0.7	14.7	246.7	0.078	157	2.75	0	0	2.77	0	0.90	0.2	0.5	85.5
C.V.(%)	52	73	10	85	38	77	69	88	31	16	55	0	0	88	0	34	67	55	50
MAX.	20	53	0.10	2.5	1.0	2.4	38.4	673.0	0.370	1240	8.24	<0.4	<2	7.00	<0.8	3.91	1.1	1.7	279.0
MIN.	6	9	<0.08	<0.04	<0.4	<0.4	3.9	22.6	0.160	764	0.38	<0.4	<2	<0.08	<0.8	1.74	<0.2	<0.4	22.7

APPENDIX IIIC Tissue Trace Metal Concentrations - Descriptive Statistics - Vancouver Harbour, January 1986

Station	Concentration (µg/g dry weight)																		
	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	Ti	V	Zn
- GILL																			
MEAN(6)	53	5	1.70	0.09	0.4	1.3	3.3	225.5	0.142	1210	10.76	0.4	2	1.56	0.8	310	1.2	0.9	71.0
S.D.	25	2	0.55	0.02	0	0.1	1.1	62.4	0.029	42	4.07	0	0	2.30	0	31	0.8	0.4	9.9
C.V.(%)	48	29	32	19	0	11	33	28	20	3	38	0	0	147	0	10	68	46	14
MAX.	84	7	2.58	0.11	<0.4	1.5	4.8	325.0	0.170	1250	18.70	<0.4	2	5.00	<0.8	359	2.3	1.6	82.9
MIN.	20	<4	1.08	0.07	<0.4	1.1	2.6	176.0	0.090	1140	7.44	<0.4	<2	<0.08	<0.8	281	0.3	0.5	58.2
PORT MOODY (PM) - TRAWL #1																			
ENGLISH SOLE (Parophrys vetulus) - MUSCLE																			
MEAN(6)	19	61	0.17	0.04	0.4	1.3	1.9	63.4	0.422	1287	0.81	0.4	10	0.08	0.8	2.51	1.0	0.4	21.0
S.D.	6	27	0.13	0.01	0	1.6	0.6	49.6	0.202	117	0.39	0	13	0.01	0	0.90	0.6	0	1.6
C.V.(%)	29	45	76	25	0	121	29	78	48	9	48	0	140	10	0	36	53	0	8
MAX.	25	97	0.42	0.06	<0.4	4.6	2.7	158.0	0.733	1460	1.53	<0.4	35	0.10	<0.8	3.83	1.5	<0.4	23.0
MIN.	12	27	<0.08	<0.04	<0.4	0.5	1.4	25.7	0.140	1180	0.47	<0.4	<2	<0.08	<0.8	1.79	0.3	<0.4	19.3
- LIVER																			
MEAN(6)	22	17	0.10	2.4	0.8	0.9	20.6	496.4	0.357	993	5.85	0.4	2	4.93	0.8	3.23	0.9	3.4	113.3
S.D.	9	4	0.04	2.9	0.6	0.2	11.6	448.8	0.410	109	1.44	0	0	3.28	0	1.05	0.3	2.5	12.6
C.V.(%)	41	25	37	122	70	24	56	90	115	11	25	0	0	67	0	32	35	73	11
MAX.	35	21	0.16	8.3	1.9	1.2	39.0	1140	1.060	1120	7.65	<0.4	<2	8.00	<0.8	4.63	1.4	8.3	133.0
MIN.	12	9	<0.08	0.7	<0.4	0.6	8.7	66.3	0.080	795	3.37	<0.4	<2	0.64	<0.8	2.06	0.6	1.8	102.0
- GILL																			
MEAN(6)	97	4.2	1.83	0.10	0.4	1.5	4.8	249	0.150	1265	10.64	0.4	2	3.21	0.8	295	2.9	1.4	65.0
S.D.	49	0.4	0.37	0.03	0	0.3	1.9	63	0.055	164	3.23	0	1	2.42	0	57	1.9	0.4	5.4
C.V.(%)	50	10	20	26	0	19	38	25	37	13	30	0	49	75	0	19	67	26	8
MAX.	193	5	2.30	0.12	<0.4	1.9	8.3	350	0.260	1400	16.80	<0.4	5	5.00	<0.8	372	6.7	1.9	69.1
MIN.	62	<4	1.32	0.05	<0.4	1.1	3.0	163	0.120	989	7.45	<0.4	<2	0.11	<0.8	208	1.8	0.9	54.7

APPENDIX IIIC **Tissue Trace Metal Concentrations - Descriptive Statistics - Vancouver Harbour, January 1986**

Station	Concentration (μg/g dry weight)																		
	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	Ti	V	Zn
PORT MOODY (PM) - TRAWL #2																			
ENGLISH SOLE (Parophrys vetulus) - MUSCLE																			
MEAN(6)	8	47	0.10	0.04	0.4	0.5	1.0	21.9	0.338	1260	0.50	0.4	2	0.08	0.8	5.27	0.4	0.4	22.1
S.D.	2	33	0.05	0	0	0.1	0.3	5.9	0.081	62	0.13	0	0	0	0	7.85	0.3	0	2.2
C.V.(%)	29	71	49	0	0	15	32	27	24	5	26	0	0	0	0	149	62	0	10
MAX.	11	113	0.20	<0.04	<0.4	0.6	1.5	32.4	0.420	1340	0.73	<0.4	<2	<0.08	<0.8	21.20	0.8	<0.4	25.2
MIN.	6	26	<0.08	<0.04	<0.4	0.4	0.7	15.7	0.190	1170	0.38	<0.4	<2	<0.08	<0.8	1.32	<0.2	<0.4	19.1
- LIVER																			
MEAN(6)	21	12	0.08	1.3	2.0	0.8	5.0	601	0.195	835	4.01	0.4	2.2	0.49	0.8	2.22	0.7	3.4	100.2
S.D.	8	5	0	1.0	2.4	0.3	1.2	388	0.024	148	0.93	0	0.4	0.24	0	0.43	0.2	1.5	20.3
C.V.(%)	39	42	0	83	121	43	24	65	12	18	23	0	19	50	5	19	22	45	20
MAX.	31	22	0.08	2.8	6.8	1.5	6.4	1330	0.230	1030	5.44	<0.4	3	0.72	<0.9	2.73	1.0	5.3	137.0
MIN.	11	8	<0.08	0.4	0.5	0.5	3.4	304	0.170	629	3.03	<0.4	<2	0.21	<0.8	1.56	0.6	1.9	79.4
- GILL																			
MEAN(6)	90	4	2.19	0.19	0.4	1.6	2.3	287	0.228	1187	9.67	0.4	2	2.23	0.8	336	2.5	1.5	72.4
S.D.	38	1	0.79	0.17	0.1	0.3	0.5	79	0.024	95	1.52	0	0	3.19	0	94	1.3	0.5	3.3
C.V.(%)	43	27	36	89	27	16	21	27	11	8	16	0	0	143	0	28	54	35	5
MAX.	145	7	3.45	0.50	0.7	2.1	2.8	386	0.270	1280	11.80	<0.4	<2	8.00	<0.8	503	4.2	2.4	78.0
MIN.	34	<4	1.39	0.06	<0.4	1.3	1.5	163	0.210	1050	7.29	<0.4	<2	0.18	<0.8	270	0.4	0.9	68.1
OTHER FISH SPECIES																			
CENTRE (CT)																			
SHINNER PERCH (Cymatogaster aggregata) - MUSCLE																			
MEAN(3)	8	5	0.09	0.04	0.4	0.7	2.5	21.9	0.293	1460	1.73	0.4	2	0.08	0.8	9.65	0.2	0.5	22.5
S.D.	5	2	0.01	0	0	0.3	1.2	6.0	0.155	78	0.34	0.1	0	0	0	3.69	0	0.1	3.6
C.V.(%)	59	29	13	0	0	38	49	28	53	5	20	13	0	0	0	38	0	25	16
MAX.	14	7	0.10	<0.04	0.4	1.0	3.9	27.1	0.450	1510	2.09	0.5	2	<0.08	<0.8	13.90	0.2	0.6	26.4
MIN.	5	4	<0.08	<0.04	<0.4	0.5	1.5	15.3	0.140	1370	1.41	<0.4	<2	<0.08	<0.8	7.24	<0.2	<0.4	19.3

APPENDIX IV

TRACE METAL CONCENTRATIONS OF STANDARD REFERENCE MATERIALS (BOVINE LIVER AND TORT-1, LOBSTER HEPATOPANCREAS) AND PERCENT RECOVERY BY EP LABORATORY FOR EACH SET OF SAMPLES

A. MAY 1985

B. OCTOBER 1985

C. JANUARY 1986

APPENDIX IVA TRACE METAL CONCENTRATIONS OF STANDARD REFERENCE MATERIALS (BOVINE LIVER AND TORT-1, LOBSTER HEPATOPANCREAS) AND PERCENT RECOVERY BY EP LABORATORY FOR EACH SET OF SAMPLES

	Concentration (µg/g dry weight)													
	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
STERLING, VANTERM AND CHEVRON SAMPLES														
BOVINE LIVER MUSCLE REFERENCE VALUES														
MEAN	30	0.053	0.1	0.276	0.65	189	263	-	587	10.2	3.1	0.4	0.35	132
±95% C.L.	20	0.01	-	0.023	0.13	21	13	-	20	0.9	0.5	0.4	0.6	10
LAB RESULTS														
	<4.0	<4.0	<0.08	0.42	1.1	194	258	-	535	10.7	3.5	<2	1.59	136
	<4.0	<4.0	<0.08	0.44	1.6	189	256	-	519	10.5	3.0	<2	1.43	132
	<4.0	<4.0	<0.08	0.36	0.7	195	262	-	537	10.7	3.6	<2	1.59	136
	<4.0	<4.0	<0.10	0.80	0.8	194	255	-	527	10.6	3.1	<2	1.43	135
MEAN(4)	-	-	-	0.51	1.1	193	258	-	529	10.6	3.3	-	1.51	135
% RECOVERY	-	-	-	183	162	102	98	-	90	104	106	-	431	102
TORT - 1 (LOBSTER HEPATOPANCREAS) REFERENCE VALUES														
MEAN	-	24.6	-	26.3	2.4	439	186	0.33	2550	23.4	1.5	2.3	10.4	177
±95% C.L.	-	2.2	-	2.1	0.6	22	11	0.06	250	1.0	0.3	0.3	2.0	10
LAB RESULTS														
	9	25	2.94	23.4	3.0	377	171	0.24	2070	21.7	1.5	<2.0	9.0	157
	11	27	3.28	25.4	2.8	415	172	0.39	2220	23.4	0.9	<2.0	8.0	171
	10	26	3.33	24.1	2.5	405	169	0.24	2140	23.1	1.6	<2.0	10.0	164
	12	26	3.15	24.3	2.5	397	162	0.26	2150	22.8	1.6	<2.0	10.0	164
MEAN(4)	11	26	3.18	24.3	2.7	399	169	0.28	2145	22.8	1.4	-	9.3	164
% RECOVERY	-	106	-	92	113	91	91	86	84	97	93	-	89	93

APPENDIX IVA TRACE METAL CONCENTRATIONS OF STANDARD REFERENCE MATERIALS (BOVINE LIVER AND TORT-1, LOBSTER HEPATOPANCREAS) AND PERCENT RECOVERY BY EP LABORATORY FOR EACH SET OF SAMPLES

	Concentration (μg/g dry weight)													
	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
CATES PARK SAMPLES														
BOVINE LIVER REFERENCE VALUES														
MEAN	30	0.053	0.1	0.276	0.65	189	263	-	587	10.2	3.1	0.4	0.35	132
+95% C.L.	20	0.01	-	0.023	0.13	21	13	-	20	0.9	0.5	0.4	0.6	10
LAB RESULTS														
	<4	<4	0.12	0.48	0.7	204	264	-	574	10.4	3.8	<2	2.70	144
	<4	<4	0.12	0.54	0.6	200	262	-	570	10.4	3.5	<2	2.80	142
	<4	<4	<0.08	0.52	0.6	205	263	-	588	10.6	3.8	<2	1.89	147
	<4	<4	0.09	0.52	0.7	201	261	-	569	10.4	3.8	<2	2.34	143
	<4	<4	0.11	0.50	0.8	200	265	-	572	10.4	3.7	<2	2.14	143
MEAN(5)	-	-	0.11	0.51	0.7	202	263	-	575	10.4	3.7	-	2.37	144
% RECOVERY	-	-	-	186	105	107	100	-	98	102	120	-	678	109
TORT - 1 (LOBSTER HEPATOPANCREAS) REFERENCE VALUES														
MEAN	-	24.6	-	26.3	2.4	439	186	0.33	2550	23.4	1.5	2.3	10.4	177
+95% C.L.	-	2.2	-	2.1	0.6	22	11	0.06	250	1.0	0.3	0.3	2.0	10
LAB RESULTS														
	9	28	3.40	24.3	1.8	420	188	0.23	2310	22.1	1.2	2	14	175
	9	28	3.25	23.7	1.8	412	193	0.23	2300	22.1	1.4	3	11	171
	8	28	3.24	23.8	1.5	411	168	0.23	2300	21.7	0.9	<2	35	172
	8	28	3.24	24.0	1.4	418	140	0.18	2310	21.7	1.2	2	22	172
	6	28	3.31	23.6	1.5	410	159	0.15	2290	21.7	1.2	2	10	170
MEAN(5)	8	28	3.29	23.9	1.6	414	170	0.20	2302	21.9	1.2	-	18	172
% RECOVERY	-	114	-	91	67	94	91	62	90	93	79	-	177	97

APPENDIX IVA TRACE METAL CONCENTRATIONS OF STANDARD REFERENCE MATERIALS (BOVINE LIVER AND TORT-1, LOBSTER HEPATOPANCREAS) AND PERCENT RECOVERY BY EP LABORATORY FOR EACH SET OF SAMPLES

	Concentration (µg/g dry weight)													
	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
BOULDER ROCK SAMPLES														
BOVINE LIVER REFERENCE VALUES														
MEAN	30	0.053	0.1	0.276	0.65	189	263	-	587	10.2	3.1	0.4	0.35	132
±95% C.L.	20	0.01	-	0.023	0.13	21	13	-	20	0.9	0.5	0.4	0.6	10
LAB RESULTS														
VALUE	10	<4.0	0.09	0.33	0.6	161.0	220.0	-	518	8.9	2.7	<2.0	<2.0	123.0
% RECOVERY	33	-	90	120	92	85	84	-	88	87	87	-	-	93
TORT - 1 (LOBSTER HEPATOPANCREAS) REFERENCE VALUES														
MEAN	-	24.6	-	26.3	2.4	439	189	-	2550	23.4	1.5	2.3	10.4	177
±95% C.L.	-	2.2	-	2.1	0.6	22	11	-	250	1.0	0.3	0.3	2.0	10
LAB RESULTS														
	28.0	28.0	3.3	27.8	2.6	418	206	-	2570	23.8	1.1	3	12	184
	22.0	30.0	3.3	27.2	2.7	416	155	-	2490	22.7	1.3	3	12	178
	26.0	27.0	3.2	26.9	5.4	419	173	-	2520	23.1	1.1	7	9	178
	21.0	29.0	3.3	26.5	2.2	420	177	-	2530	23.1	0.9	3	24	177
	13.0	26.0	3.0	24.4	1.2	385	150	-	2240	20.3	0.7	2	9	158
MEAN(5)	22.0	28.0	3.2	26.6	2.8	412	172	-	2470	22.6	1.0	3.6	13	175
% RECOVERY	-	114	-	101	118	94	91	-	97	97	68	157	127	99

APPENDIX IVA TRACE METAL CONCENTRATIONS OF STANDARD REFERENCE MATERIALS (BOVINE LIVER AND TORT-1, LOBSTER HEPATOPANCREAS) AND PERCENT RECOVERY BY EP LABORATORY FOR EACH SET OF SAMPLES

	Concentration (µg/g dry weight)													
	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
PORT MOODY SAMPLES														
BOVINE LIVER REFERENCE VALUES														
MEAN	30	0.053	0.1	0.276	0.65	189	263	-	587	10.2	3.1	0.4	0.35	132
±95% C.L.	20	0.01	-	0.023	0.13	21	13	-	20	0.9	0.5	0.4	0.6	10
LAB RESULTS														
	<4	<4	<0.08	0.50	0.6	183	261	-	556	9.9	3.6	<2	1.13	134
	<4	<4	0.10	0.46	0.6	184	261	-	554	10.1	3.4	<2	1.82	134
	<4	<4	<0.08	0.48	0.7	193	266	-	569	10.4	3.9	<2	1.22	141
	<4	<4	<0.08	0.50	0.5	200	280	-	595	10.8	4.1	<2	1.09	146
	<4	<4	0.09	0.30	0.6	196	271	-	574	10.5	3.4	<2	1.43	140
MEAN(5)	-	-	-	0.45	0.6	191	268	-	570	10.3	3.7	-	1.34	139
% RECOVERY	-	-	-	162	92	101	102	-	97	101	119	-	382	105
TORT - 1 (LOBSTER HEPATOPANCREAS) REFERENCE VALUES														
MEAN	-	24.6	-	26.3	2.4	439	186	-	2550	23.4	1.5	2.3	10.4	177
±95% C.L.	-	2.2	-	2.1	0.6	22	11	-	250	1.0	0.3	0.3	2.0	10
LAB RESULTS														
	9	26	3.25	24.6	1.7	395	156	-	2310	21.6	1.5	2	9	168
	12	27	3.30	25.1	1.7	400	155	-	2330	22.0	1.3	<2	12	171
	11	27	3.18	23.8	1.7	389	173	-	2240	21.4	1.0	<2	10	164
	9	26	3.23	24.3	1.3	409	152	-	2240	21.6	1.1	<2	8	169
	9	25	3.23	24.0	1.4	392	145	-	2230	21.2	1.4	<2	8	166
MEAN	10	26	3.24	24.4	1.6	397	156	-	2270	21.6	1.3	-	9.4	168
% RECOVERY	-	107	-	93	65	90	84	-	89	92	84	-	90	95

APPENDIX IVA TRACE METAL CONCENTRATIONS OF STANDARD REFERENCE MATERIALS (BOVINE LIVER AND TORT-1, LOBSTER HEPATOPANCREAS) AND PERCENT RECOVERY BY EP LABORATORY FOR EACH SET OF SAMPLES

	Concentration ($\mu g/g$ dry weight)													
	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Zn
PEI, BURRARD YARROWS AND COAL HARBOUR SAMPLES														
TORT-1 (LOBSTER HEPATOPANCREAS) REFERENCE VALUES														
MEAN	-	24.6	-	26.3	2.4	439	186	0.33	2550	23.4	1.5	2.3	10.4	177
±95% C.L.	-	2.2	-	2.1	0.6	22	11	0.06	250	1.0	0.3	0.3	2.0	10
LAB RESULTS														
	13	23	3.26	25.9	2.0	353	172	0.36	2100	18.8	1.7	<2	11	198
	12	27	3.84	29.5	2.3	434	147	0.32	2030	21.2	1.4	<2	10	233
	17	26	3.34	26.3	2.5	370	164	0.32	2150	19.3	1.7	<2	11	207
	15	22	3.41	25.9	2.1	363	145	0.28	2100	19.1	1.6	<2	9	202
MEAN(4)	14	25	3.46	26.9	2.2	380	157	0.32	2095	19.6	1.6	-	10	210
% RECOVERY	-	100	-	102	93	87	84	97	82	84	107	-	99	119

APPENDIX IVB TRACE METAL CONCENTRATIONS OF STANDARD REFERENCE MATERIALS (BOVINE LIVER AND TORT-1, LOBSTER HEPATOPANCREAS) AND PERCENT RECOVERY BY EP LABORATORY FOR EACH SET OF SAMPLES - OCTOBER 1985

	Concentration (µg/g-dry weight)																		
	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	Ti	V	Zn
SHRIMP SAMPLES FROM PORT MOODY AND STERLING																			
BOVINE LIVER REFERENCE VALUES																			
MEAN	30	0.053	0.1	0.276	0.24	0.65	189	263	-	587	10.2	3.1	0.4	0.35	0.016	0.22	2	33	132
+95% C.L.	20	0.01	-	0.023	0.06	0.13	21	13	-	20	0.9	0.5	0.4	0.6	-	-	-	-	10
LAB RESULTS																			
	<4	<4	<0.08	0.50	1.60	0.8	170.0	245.0	-	536	9.81	4.3	<2	0.91	<0.8	<0.8	6.0	<0.4	126.0
	<4	<4	<0.08	0.30	1.40	1.1	183.0	244.0	-	531	10.10	4.3	<2	0.91	<0.8	0.15	7.1	<0.4	130.0
	<4	<4	<0.08	0.50	1.00	0.6	188.0	243.0	-	531	10.10	4.1	<2	<2	<0.8	<0.8	7.2	<0.4	131.0
	<4	<4	<0.08	0.20	0.90	0.8	166.0	244.0	-	529	9.57	4.1	<2	0.71	<0.8	0.10	5.7	<0.4	123.0
	<4	<4	<0.08	0.30	1.10	0.8	129.0	245.0	-	529	8.03	3.9	<2	<2	<0.8	<0.8	3.8	<0.4	101.0
MEAN(5)	-	-	-	0.36	1.20	0.82	167	244	-	531	9.52	4.1	-	-	-	-	6.0	-	122
% RECOVERY	-	-	-	130	500	126	88	93	-	90	93	132	-	-	-	-	300	-	92
TORT-1 (LOBSTER HEPATOPANCREAS) REFERENCE VALUES																			
MEAN	-	24.6	-	26.3	0.42	2.4	439	186	0.33	2550	23.4	1.5	2.3	10.4	-	113	-	1.4	177
+95% C.L.	-	2.2	-	2.1	0.05	0.6	22	11	0.06	250	1	0.3	0.3	2	-	5	-	0.3	10
LAB RESULTS																			
	9	21	2.59	21.30	1.10	1.5	310.0	147.0	0.89	1960	18.40	0.8	3	7	<0.8	82.60	5.5	0.9	135.0
	9	22	2.50	20.70	0.90	1.5	300.0	129.0	0.82	1950	17.30	1.3	<2	8	<0.8	77.90	5.2	0.9	131.0
	14	22	2.57	21.80	0.90	1.5	319.0	142.0	0.94	2030	18.30	1.8	2	16	<0.8	79.90	5.8	0.9	138.0
	13	20	2.59	22.60	1.40	2.0	321.0	144.0	0.92	2030	18.70	1.3	3	9	<0.8	83.50	5.8	0.9	143.0
	10	24	2.74	22.60	0.80	1.7	344.0	131.0	0.97	2020	19.60	1.8	<2	9	<0.8	85.70	6.4	0.9	146.0
MEAN(5)	11	22	2.60	21.8	1.0	1.6	319	139	0.91	1998	18.5	1.4	3	10	-	81.9	5.7	0.9	139
% RECOVERY	-	89	-	83	238	67	73	75	276	78	79	93	-	96	-	72	-	64	79

APPENDIX IVB TRACE METAL CONCENTRATIONS OF STANDARD REFERENCE MATERIALS (BOVINE LIVER AND TORT-1, LOBSTER HEPATOPANCREAS) AND PERCENT RECOVERY BY EP LABORATORY FOR EACH SET OF SAMPLES - OCTOBER 1985

	Concentration (µg/g-dry weight)																		
	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	Ti	V	Zn
SHRIMP SAMPLES FROM PEI, BURRARD YARROWS AND COAL HARBOUR																			
BOVINE LIVER REFERENCE VALUES																			
MEAN	30	0.053	0.1	0.276	0.24	0.65	169	263	-	587	10.2	3.1	0.4	0.35	2.016	0.22	2	33	132
±95% C.L.	20	0.01	-	0.023	0.06	0.13	21	13	-	20	0.9	0.5	0.4	0.6	-	-	-	-	-
LAB RESULTS																			
	<4	<4	0.10	0.33	0.5	1.0	169	243	-	501	9.72	3.9	<2	0.59	<0.8	<0.08	4.1	<0.4	130
	<4	<4	0.13	0.31	<0.4	0.7	167	236	-	489	9.46	4.1	<2	0.57	<0.8	<0.08	4.1	<0.4	129
	<4	<4	0.08	0.32	1.4	0.7	165	230	-	493	9.36	3.8	<2	0.51	<0.8	<0.08	3.7	<0.4	130
	<4	<4	0.10	0.32	1.2	0.7	174	245	-	510	9.96	3.5	<2	0.47	<0.8	<0.08	4.4	<0.4	139
	<4	<4	0.08	0.31	0.6	0.7	164	284	-	489	9.65	3.4	<2	0.47	<0.8	<0.08	3.8	<0.4	130
MEAN(5)	-	-	0.10	0.32	0.9	0.8	168	248	-	494	9.63	3.7	-	0.52	-	-	4.0	-	132
% RECOVERY	-	-	98	115	385	117	89	94	-	84	94	121	-	149	-	-	20	-	100
TORT-1 (LOBSTER HEPATOPANCREAS) REFERENCE VALUES																			
MEAN	-	24.6	-	26.3	0.42	2.4	439	186	0.33	2550	23.4	1.5	2.3	10.4	-	113	-	1.4	177
±95% C.L.	-	2.2	-	2.1	0.05	0.6	22	11	0.06	250	1	0.3	0.3	2	-	5	-	0.3	10
LAB RESULTS																			
	16	25	3.19	22.8	0.6	2.4	345	151	0.43	2010	20.7	1.4	6	9	<0.8	96.8	4.1	0.9	163
	17	28	3.54	25.8	0.7	2.4	394	155	0.40	2240	23.0	1.3	2	11	<0.8	106.0	5.0	1.0	186
	9	25	3.56	21.1	0.7	1.5	324	133	0.36	1890	19.1	0.6	2	8	<0.8	91.2	3.6	0.9	150
	10	25	2.98	21.2	0.7	1.6	326	129	0.36	1920	19.4	1.2	2	6	<0.8	95.4	3.6	0.7	151
	13	23	3.09	22.1	0.6	2.6	340	146	0.30	1980	20.3	0.5	2	8	<0.8	98.0	4.2	0.8	158
MEAN(5)	13	25	3.27	22.6	0.7	2.1	346	143	0.37	2008	20.5	1.0	3	8	-	97.7	4.1	0.9	162
% RECOVERY	-	102	-	86	157	88	79	77	112	79	88	67	122	81	-	86	-	61	91

APPENDIX IVB TRACE METAL CONCENTRATIONS OF STANDARD REFERENCE MATERIALS (BOVINE LIVER AND TORT-1, LOBSTER HEPATOPANCREAS) AND PERCENT RECOVERY BY EP LABORATORY FOR EACH SET OF SAMPLES - OCTOBER 1985

	Concentration (µg/g-dry weight)																		
	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	Ti	V	Zn
CRAB SAMPLES FROM PEI, BURRARD INLET, COAL HARBOUR, PORT MOODY AND STERLING																			
BOVINE LIVER REFERENCE VALUES																			
MEAN	30	0.053	0.1	0.276	0.24	0.65	189	263	-	587	10.2	3.1	0.4	0.35	0.16	0.22	2	33	132
±95% C.L.	20	0.01	-	0.023	0.060	0.13	21	13	-	20	0.9	0.5	0.4	0.6	-	-	-	-	10
LAB RESULTS																			
	<4	<4	<0.08	0.31	0.7	0.8	202	257	-	575	10.1	4.5	<2	0.67	<0.8	0.12	7.5	<0.4	138
	<4	<4	0.09	0.30	<0.4	0.9	211	262	-	581	10.3	4.0	<2	0.72	<0.8	0.1	8.1	<0.4	141
	<4	<4	0.09	0.31	<0.4	0.8	218	267	-	597	10.6	4.2	<2	0.69	<0.8	0.08	8.4	<0.4	146
	<4	<4	<0.08	0.33	<0.4	0.9	200	264	-	584	10.3	4.4	<2	0.98	<0.8	0.16	7.3	<0.4	138
	<4	<4	0.09	0.36	<0.4	0.9	201	264	-	588	10.2	4.9	2	0.59	<0.8	<0.08	7.5	<0.4	139
MEAN(5)	-	-	0.09	0.32	-	0.9	206	263	-	585	10.3	4.4	-	0.73	-	0.12	7.8	-	140
% RECOVERY	-	-	90	120	-	132	109	100	-	100	100	145	-	209	-	55	390	-	106
TORT-1 (LOBSTER HEPATOPANCREAS) REFERENCE VALUES																			
MEAN	-	24.6	-	26.3	0.42	2.4	439	186	0.33	2550	23.4	1.5	2.3	10.4	-	113	-	1.4	177
±95% C.L.	-	2.2	-	2.1	0.05	0.6	22	11	0.06	250	1	0.3	0.3	2	-	5	-	0.3	10
LAB RESULTS																			
	14	25	3.51	26.5	0.4	2.0	439	190	0.46	2470	22.9	1.8	<2	9	<0.8	111	7.8	1.2	177
	13	27	3.32	25.8	0.4	2.1	401	164	0.46	2410	21.7	1.3	<2	10	<0.8	104	7.3	1	171
	9	24	3.48	26.0	0.6	2.1	434	155	0.41	2370	21.6	1.3	<2	9	<0.8	109	8	0.9	174
	11	24	3.63	25.8	0.5	1.8	430	166	0.40	2340	21.6	1.7	3	9	<0.8	109	7.7	1.1	171
	10	28	3.55	27.0	0.6	1.9	441	166	0.38	2460	22.3	1.1	<2	9	<0.8	111	7.8	1.2	180
MEAN(5)	11	26	3.50	26.2	0.5	2.0	429	168	0.42	2410	22.0	1.4	-	9	-	109	7.7	1.1	175
% RECOVERY	-	106	-	99	119	83	98	90	128	95	94	96	-	88	-	96	-	7.9	99

APPENDIX IVB TRACE METAL CONCENTRATIONS OF STANDARD REFERENCE MATERIALS (BOVINE LIVER AND TORT-1, LOBSTER HEPATOPANCREAS) AND PERCENT RECOVERY BY EP LABORATORY FOR EACH SET OF SAMPLES - OCTOBER 1985

	Concentration (µg/g-dry weight)																		
	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	Ti	V	Zn
SHRIMP SAMPLES FROM PORT MOODY AND STERLING																			
BOVINE LIVER REFERENCE VALUES																			
MEAN	30	0.053	0.1	0.276	0.24	0.65	189	263	-	587	10.2	3.1	0.4	0.35	0.016	0.22	2	33	132
±95% C.L.	20	0.01	-	0.023	0.06	0.13	21	13	-	20	0.9	0.5	0.4	0.6	-	-	-	-	10
LAB RESULTS																			
	<4	<4	<0.08	0.50	1.60	0.8	170.0	245.0	-	536	9.81	4.3	<2	0.91	<0.8	<0.8	6.0	<0.4	126.0
	<4	<4	<0.08	0.30	1.40	1.1	183.0	244.0	-	531	10.10	4.3	<2	0.91	<0.8	0.15	7.1	<0.4	130.0
	<4	<4	<0.08	0.50	1.00	0.6	188.0	243.0	-	531	10.10	4.1	<2	<2	<0.8	<0.8	7.2	<0.4	131.0
	<4	<4	<0.08	0.20	0.90	0.8	166.0	244.0	-	529	9.57	4.1	<2	0.71	<0.8	0.10	5.7	<0.4	123.0
	<4	<4	<0.08	0.30	1.10	0.8	129.0	245.0	-	529	8.03	3.9	<2	<2	<0.8	<0.8	3.8	<0.4	101.0
MEAN(5)	-	-	-	0.36	1.20	0.82	167	244	-	531	9.52	4.1	-	-	-	-	6.0	-	122
% RECOVERY	-	-	-	130	500	126	88	93	-	90	93	132	-	-	-	-	300	-	92
TORT-1 (LOBSTER HEPATOPANCREAS) REFERENCE VALUES																			
MEAN	-	24.6	-	26.3	0.42	2.4	439	186	0.33	2550	23.4	1.5	2.3	10.4	-	113	-	1.4	177
±95% C.L.	-	2.2	-	2.1	0.05	0.6	22	11	0.06	250	1	0.3	0.3	2	-	5	-	0.3	10
LAB RESULTS																			
	9	21	2.59	21.30	1.10	1.5	310.0	147.0	0.89	1960	18.40	0.8	3	7	<0.8	82.60	5.5	0.9	135.0
	9	22	2.50	20.70	0.90	1.5	300.0	129.0	0.82	1950	17.30	1.3	<2	8	<0.8	77.90	5.2	0.9	131.0
	14	22	2.57	21.80	0.90	1.5	319.0	142.0	0.94	2030	18.30	1.8	2	16	<0.8	79.90	5.8	0.9	138.0
	13	20	2.59	22.60	1.40	2.0	321.0	144.0	0.92	2030	18.70	1.3	3	9	<0.8	83.50	5.8	0.9	143.0
	10	24	2.74	22.60	0.80	1.7	344.0	131.0	0.97	2020	19.60	1.8	<2	9	<0.8	85.70	6.4	0.9	146.0
MEAN(5)	11	22	2.60	21.8	1.0	1.6	319	139	0.91	1998	18.5	1.4	3	10	-	81.9	5.7	0.9	139
% RECOVERY	-	89	-	83	238	67	73	75	276	78	79	93	-	96	-	72	-	64	79

APPENDIX IVB TRACE METAL CONCENTRATIONS OF STANDARD REFERENCE MATERIALS (BOVINE LIVER AND TORT-1, LOBSTER HEPATOPANCREAS) AND PERCENT RECOVERY BY EP LABORATORY FOR EACH SET OF SAMPLES - OCTOBER 1985

	Concentration (µg/g-dry weight)																		
	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	Ti	V	Zn
SHRIMP SAMPLES FROM PEI, BURRARD YARROWS AND COAL HARBOUR																			
BOVINE LIVER REFERENCE VALUES																			
MEAN	30	0.053	0.1	0.276	0.24	0.65	169	263	-	587	10.2	3.1	0.4	0.35	2.016	0.22	2	33	132
±95% C.L.	20	0.01	-	0.023	0.06	0.13	21	13	-	20	0.9	0.5	0.4	0.6	-	-	-	-	-
LAB RESULTS																			
	<4	<4	0.10	0.33	0.5	1.0	169	243	-	501	9.71	3.9	<2	0.59	<0.8	<0.08	4.1	<0.4	130
	<4	<4	0.13	0.31	<0.4	0.7	167	236	-	489	9.46	4.1	<2	0.57	<0.8	<0.08	4.1	<0.4	129
	<4	<4	0.08	0.32	1.4	0.7	165	230	-	493	9.36	3.8	<2	0.51	<0.8	<0.08	3.7	<0.4	130
	<4	<4	0.10	0.32	1.2	0.7	174	245	-	510	9.96	3.5	<2	0.47	<0.8	<0.08	4.4	<0.4	139
	<4	<4	0.08	0.31	0.6	0.7	164	284	-	489	9.65	3.4	<2	0.47	<0.8	<0.08	3.8	<0.4	130
MEAN(5)	-	-	0.10	0.32	0.9	0.8	168	248	-	494	9.63	3.7	-	0.52	-	-	4.0	-	132
% RECOVERY	-	-	98	115	385	117	89	94	-	84	94	121	-	149	-	-	20	-	100
TORT-1 (LOBSTER HEPATOPANCREAS) REFERENCE VALUES																			
MEAN	-	24.6	-	26.3	0.42	2.4	439	186	0.33	2550	23.4	1.5	2.3	10.4	-	113	-	1.4	177
±95% C.L.	-	2.2	-	2.1	0.05	0.6	22	11	0.06	250	1	0.3	0.3	2	-	5	-	0.3	10
LAB RESULTS																			
	16	25	3.19	22.8	0.6	2.4	345	151	0.43	2010	20.7	1.4	6	9	<0.8	96.8	4.1	0.9	163
	17	28	3.54	25.8	0.7	2.4	394	155	0.40	2240	23.0	1.3	2	11	<0.8	106.0	5.0	1.0	186
	9	25	3.56	21.1	0.7	1.5	324	133	0.36	1890	19.1	0.6	2	8	<0.8	91.2	3.6	0.9	150
	10	25	2.98	21.2	0.7	1.6	326	129	0.36	1920	19.4	1.2	2	6	<0.8	95.4	3.6	0.7	151
	13	23	3.09	22.1	0.6	2.6	340	146	0.30	1980	20.3	0.5	2	8	<0.8	98.0	4.2	0.8	158
MEAN(5)	13	25	3.27	22.6	0.7	2.1	346	143	0.37	2008	20.5	1.0	3	8	-	97.7	4.1	0.9	162
% RECOVERY	-	102	-	86	157	88	79	77	112	79	88	67	122	81	-	86	-	61	91

APPENDIX IVB TRACE METAL CONCENTRATIONS OF STANDARD REFERENCE MATERIALS (BOVINE LIVER AND TORT-1, LOBSTER HEPATOPANCREAS) AND PERCENT RECOVERY BY EP LABORATORY FOR EACH SET OF SAMPLES - OCTOBER 1985

	Concentration (µg/g-dry weight)																		
	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	Ti	V	Zn
CRAB SAMPLES FROM PEI, BURRARD YARROWS, COAL HARBOUR, PORT MOODY AND STERLING																			
BOVINE LIVER REFERENCE VALUES																			
MEAN	30	0.053	0.1	0.276	0.24	0.65	189	263	-	587	10.2	3.1	0.4	0.35	0.16	0.22	2	33	132
±95% C.L.	20	0.01	-	0.023	0.060	0.13	21	13	-	20	0.9	0.5	0.4	0.6	-	-	-	-	10
LAB RESULTS																			
	<4	<4	<0.08	0.31	0.7	0.8	202	257	-	575	10.1	4.5	<2	0.67	<0.8	0.12	7.5	<0.4	138
	<4	<4	0.09	0.30	<0.4	0.9	211	262	-	581	10.3	4.0	<2	0.72	<0.8	0.1	8.1	<0.4	141
	<4	<4	0.09	0.31	<0.4	0.8	218	267	-	597	10.6	4.2	<2	0.69	<0.8	0.08	8.4	<0.4	146
	<4	<4	<0.08	0.33	<0.4	0.9	200	264	-	584	10.3	4.4	<2	0.98	<0.8	0.16	7.3	<0.4	138
	<4	<4	0.09	0.36	<0.4	0.9	201	264	-	588	10.2	4.9	2	0.59	<0.8	<0.08	7.5	<0.4	139
MEAN(5)	-	-	0.09	0.32	-	0.9	206	263	-	585	10.3	4.4	-	0.73	-	0.12	7.8	-	140
% RECOVERY	-	-	90	120	-	132	109	100	-	100	100	145	-	209	-	55	390	-	106
TORT-1 (LOBSTER HEPATOPANCREAS) REFERENCE VALUES																			
MEAN	-	24.6	-	26.3	0.42	2.4	439	186	0.33	2550	23.4	1.5	2.3	10.4	-	113	-	1.4	177
±95% C.L.	-	2.2	-	2.1	0.05	0.6	22	11	0.06	250	1	0.3	0.3	2	-	5	-	0.3	10
LAB RESULTS																			
	14	25	3.51	26.5	0.4	2.0	439	190	0.46	2470	22.9	1.8	<2	9	<0.8	111	7.8	1.2	177
	13	27	3.32	25.8	0.4	2.1	401	164	0.46	2410	21.7	1.3	<2	10	<0.8	104	7.3	1	171
	9	24	3.48	26.0	0.6	2.1	434	155	0.41	2370	21.6	1.3	<2	9	<0.8	109	8	0.9	174
	11	24	3.63	25.8	0.5	1.8	430	166	0.40	2340	21.6	1.7	3	9	<0.8	109	7.7	1.1	171
	10	28	3.55	27.0	0.6	1.9	441	166	0.38	2460	22.3	1.1	<2	9	<0.8	111	7.8	1.2	180
MEAN(5)	11	26	3.50	26.2	0.5	2.0	429	168	0.42	2410	22.0	1.4	-	9	-	109	7.7	1.1	175
% RECOVERY	-	106	-	99	119	83	98	90	128	95	94	96	-	88	-	96	-	7.9	99

APPENDIX IVB TRACE METAL CONCENTRATIONS OF STANDARD REFERENCE MATERIALS (BOVINE LIVER AND TORT-1, LOBSTER HEPATOPANCREAS) AND PERCENT RECOVERY BY EP LABORATORY FOR EACH SET OF SAMPLES - OCTOBER 1985

	Concentration (µg/g-dry weight)																		
	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	Ti	V	Zn
SOLE SAMPLES FROM PKI, BURRARD YARROWS																			
BOVINE LIVER REFERENCE VALUES																			
MEAN	30	0.053	0.1	0.276	0.24	0.65	189	263	-	587	10.2	3.1	0.4	0.35	0.16	0.22	2	33	132
$\pm$95% C.L.	20	0.01	-	0.023	0.06	0.13	21	13	-	20	0.9	0.5	0.4	0.6	-	-	-	-	10
LAB RESULTS																			
	<4	<4	0.11	0.29	0.6	2.3	194	288	-	541	10.9	3.5	3	0.82	<0.8	0.39	6.0	<0.4	142
	<4	<4	<0.08	0.28	0.8	0.6	184	261	-	520	10.4	3.2	<2	0.46	<0.8	0.16	5.7	<0.4	139
	5	<4	0.09	0.31	0.8	0.7	176	265	-	503	10.5	2.6	<2	0.64	<0.8	0.23	5.5	<0.4	141
	<4	<4	0.08	0.32	0.7	0.7	172	267	-	485	10.6	2.7	<2	0.43	<0.8	0.17	5.5	<0.4	140
	<4	<4	<0.08	0.25	0.5	0.5	170	265	-	478	10.4	2.8	<2	0.41	<0.8	0.20	5.0	<0.4	138
MEAN(5)	-	-	0.09	0.29	0.7	1.0	179	269	-	505	10.6	3.0	-	0.55	-	0.24	5.6	-	140
% RECOVERY	-	-	93	105	283	148	95	102	-	86	104	95	-	158	-	108	278	-	106
TORT-1 (LOBSTER HEPATOPANCREAS) REFERENCE VALUES																			
MEAN	-	24.6	-	26.3	0.42	2.4	439	186	0.33	2550	23.4	1.5	2.3	10.4	-	113	-	1.4	177
$\pm$95% C.L.	-	2.2	-	2.1	0.05	0.6	22	11	0.06	250	1.0	0.3	0.3	2	-	5	-	0.3	10
LAB RESULTS																			
	9	25	2.90	25.2	0.8	1.8	382	164	0.26	2050	21.7	0.8	<2	16	<0.8	94.5	4.1	1.1	168
	10	29	3.01	25.6	0.8	2.0	407	164	0.21	2170	22.4	<0.4	2	9	<0.8	98.9	4.2	1.2	172
	10	29	2.96	25.6	0.8	2.2	392	172	0.41	2120	23.0	0.4	<2	10	<0.8	98.0	4.8	1.2	169
	11	27	2.78	24.8	0.6	2.0	368	172	0.39	2010	21.3	0.5	2	10	<0.8	91.6	4.0	1.2	164
	12	27	2.91	26.7	0.7	2.0	378	148	0.50	2070	22.5	<0.4	4	10	<0.8	96.1	4.7	1.2	173
MEAN(5)	10	27	2.92	25.6	0.7	2.0	385	164	0.35	2084	22.2	0.6	-	11	-	95.3	4.5	1.2	169
% RECOVERY	-	110	-	97	167	83	88	88	97	82	94	40	-	106	-	84	-	86	85

APPENDIX IVB TRACE METAL CONCENTRATIONS OF STANDARD REFERENCE MATERIALS (BOVINE LIVER AND TORT-1, LOBSTER HEPATOPANCREAS) AND PERCENT RECOVERY BY EP LABORATORY FOR EACH SET OF SAMPLES - OCTOBER 1985

	Concentration (µg/g-dry weight)																		
	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	Ti	V	Zn
SOLE SAMPLES FROM COAL HARBOUR, PORT MOODY AND STERLING																			
BOVINE LIVER REFERENCE VALUES																			
MEAN	30	0.053	0.1	0.276	0.24	0.65	189	263	-	587	10.2	3.1	0.4	0.35	0.016	0.22	2	33	132
±95% C.L.	20	0.01	-	0.023	0.06	0.13	21	13	-	20	0.9	0.5	0.4	0.6	-	-	-	-	10
LAB RESULTS																			
	<4	<4	0.08	0.40	<0.4	0.7	131	143	-	469	7.21	5.2	<2	0.22	<0.8	0.2	<0.2	0.6	101
	<4	<4	0.08	0.53	<0.4	0.7	135	147	-	480	7.33	4.4	<2	0.24	<0.8	0.2	<0.2	0.7	104
	<4	<4	<0.08	0.50	<0.4	1.0	131	144	-	467	7.24	5.1	<2	0.23	1.5	0.13	<0.2	0.7	100
	<4	<4	<0.08	0.48	0.4	1.0	134	147	-	478	7.38	5.5	<2	0.20	1.0	0.2	<0.2	0.8	103
	<4	<4	0.08	0.48	0.5	0.9	137	149	-	486	7.53	4.8	<2	0.33	<0.8	0.2	<0.2	0.7	105
MEAN(5)	-	-	0.08	0.48	-	0.9	134	146	-	476	7.34	5.0	-	0.24	1.3	0.19	-	0.7	103
% RECOVERY	-	-	80	173	-	132	71	56	-	81	72	161	-	70	-	85	-	2	78
TORT-1 (LOBSTER HEPATOPANCREAS) REFERENCE VALUES																			
MEAN	-	24.6	-	26.3	0.42	2.4	439	186	0.33	2550	23.4	1.5	2.3	10.4	-	113	-	1.4	177
±95% C.L.	-	2.2	-	2.1	0.05	0.6	22	11	0.06	250	1.0	0.3	0.3	2	-	5	-	0.3	10
LAB RESULTS																			
	11	20	2.75	24.1	<0.4	2.2	381	128	0.34	2120	17.3	1.1	2	8	<0.8	89.7	<0.2	1.9	153
	14	21	2.40	21.4	<0.4	2.2	329	129	0.32	1830	15.1	1.5	3	8	1.0	75.4	<0.2	2.2	133
	14	20	2.42	21.7	0.4	2.4	334	121	0.28	1850	15.4	1.5	7	8	<0.8	78	<0.2	2.3	138
	19	26	2.91	25.2	0.6	2.9	384	162	0.30	2120	17.8	1.9	3	15	1.5	87.3	<0.2	2.8	155
	14	32	3.39	28.9	<0.4	3.2	465	177	0.29	2540	20.8	2.8	4	13	<0.8	106	<0.2	1.8	179
MEAN(5)	14	24	2.77	24.3	0.5	2.6	379	143	0.31	2092	17.3	1.8	4	10	-	87.3	-	2.2	152
% RECOVERY	-	97	-	92	119	108	86	77	93	82	74	117	165	100	-	77	-	157	85

APPENDIX IVB TRACE METAL CONCENTRATIONS OF STANDARD REFERENCE MATERIALS (BOVINE LIVER AND TORT-1, LOBSTER HEPATOPANCREAS) AND PERCENT RECOVERY BY EP LABORATORY FOR EACH SET OF SAMPLES - OCTOBER 1985

	Concentration (µg/g-dry weight)																		
	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	Ti	V	Zn
OTHER FISH SAMPLES FROM PEI																			
BOVINE LIVER REFERENCE VALUES																			
MEAN	30	0.053	0.1	0.276	0.240	0.65	189	263	-	587	10.2	3.1	0.4	0.35	0.016	0.22	2	33	132
±95% C.L.	20	0.010	-	0.023	0.060	0.13	21	13	-	20	0.9	0.5	0.4	0.60	-	-	-	-	10
LAB RESULTS																			
	<4	<4	<0.08	0.41	0.9	0.5	170	241	-	527	9.59	4.4	<2	<2	<0.8	<0.08	6.6	<0.4	126
	<4	<4	<0.08	0.42	1.3	0.6	187	241	-	528	10.00	3.6	<2	0.71	<0.8	<0.08	7.4	<0.4	133
	<4	<4	<0.08	0.40	1.3	0.6	171	232	-	505	9.43	4.6	<2	0.62	<0.8	<0.08	6.5	<0.4	124
	<4	<4	<0.08	0.43	0.8	0.6	160	226	-	493	8.97	4.3	<2	<2	<0.8	<0.08	5.8	<0.4	117
	<4	<4	<0.08	0.40	1.2	0.7	171	227	-	498	9.26	3.7	<2	0.84	<0.8	<0.08	6.5	<0.4	123
MEAN(5)	-	-	-	0.41	1.1	0.6	172	233	-	510	9.45	4.1	-	0.72	-	-	6.6	-	125
% RECOVERY	-	-	-	152	458	92	91	89	-	87	91	133	-	207	-	-	330	-	94
TORT-1 (LOBSTER HEPATOPANCREAS) REFERENCE VALUES																			
MEAN	-	24.6	-	26.3	0.42	2.4	439	186	0.33	2550	23.4	1.5	2.3	10.4	-	113	-	1.4	177
±95% C.L.	-	2.2	-	2.1	0.05	0.6	22	11	0.06	250	1	0.3	0.3	2	-	5	-	0.3	10
LAB RESULTS																			
	8	25	3.11	24.4	1.1	2.1	374	159	0.41	2100	20.6	1.4	<2	8	<0.8	95.2	7.4	1.1	156
	12	23	2.94	23.9	1.2	2.1	363	133	0.31	2000	20.0	1.5	2	8	<0.8	91	6.9	1	151
	10	23	2.76	22.0	0.7	1.4	322	132	0.25	1980	18.5	1.5	<2	6	<0.8	82.6	5.8	0.9	140
	8	17	2.67	22.7	1.1	1.5	326	169	0.25	2030	19.0	1.6	<2	7	<0.8	85.9	5.9	0.9	143
	8	25	2.62	22.4	0.7	1.4	329	132	0.23	2010	18.9	1.1	3	7	<0.8	84.3	6	0.9	142
MEAN(5)	9	23	2.82	23.1	1.0	1.7	343	145	0.29	2024	19.4	1.4	2.50	7	-	87.0	6.5	1.0	146
% RECOVERY	-	92	-	88	229	71	78	78	88	79	83	95	109	69	-	77	-	68	83

APPENDIX IVC TRACE METAL CONCENTRATIONS OF STANDARD REFERENCE MATERIALS (BOVINE LIVER AND TORT-1, LOBSTER HEPATOPANCREAS) AND PERCENT RECOVERY BY EP LABORATORY FOR EACH SET OF SAMPLES - JANUARY 1986

	Concentration (μg/g-dry weight)																		
	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	Ti	V	Zn
SHRIMP SAMPLES FROM PEI, PORT MOODY AND CENTRE																			
BOVINE LIVER REFERENCE VALUES																			
MEAN	30	0.053	0.1	0.276	0.24	0.65	189	263	-	587	10.2	3.1	0.4	0.35	0.016	0.22	2	33	132
±95% C.L.	20	0.01	-	0.023	0.06	0.13	21	13	-	20	0.9	0.5	0.4	0.6	-	-	-	-	10
LAB RESULTS																			
	<4	<4	<0.08	0.43	<0.4	0.6	165	189	-	595	10.6	3.2	<2	0.24	<0.8	0.09	0.05	<0.4	130
	<4	<4	<0.08	0.40	<0.4	0.6	161	181	-	572	10.1	3.2	<2	0.36	<0.8	0.13	0.05	<0.4	123
	8	<4	<0.08	0.42	<0.4	<0.4	158	211	-	591	11.8	3.1	<2	0.28	<0.8	<0.08	0.4	<0.4	142
	<4	<4	0.19	0.43	<0.4	0.9	165	188	-	595	10.5	3.6	<2	<0.08	<0.8	0.13	0.5	<0.4	129
	<4	<4	<0.08	0.42	<0.4	0.7	162	181	-	578	10.1	3.6	<2	<0.08	<0.8	0.11	0.5	<0.4	124
MEAN(5)	-	-	-	0.42	-	0.7	162	190	-	586	10.6	3.3	-	0.29	-	0.12	0.5	-	130
% RECOVERY	-	-	-	152	-	108	86	72	-	100	104	108	-	84	-	52	24	-	98
TORT-1 (LOBSTER HEPATOPANCREAS) REFERENCE VALUES																			
MEAN	-	24.6	-	26.3	0.42	2.4	439	186	0.33	2550	23.4	1.5	2.3	10.4	-	113	-	1.4	177
±95% C.L.	-	2.2	-	2.1	0.05	0.6	22	11	0.06	250	1	0.3	0.3	2	-	5	-	0.3	10
LAB RESULTS																			
	12	24	2.91	22.4	<0.4	1.90	378	142	0.40	2080	20.7	1.1	<2	9	<0.8	95.3	0.8	1.00	158
	12	23	2.68	21.6	<0.4	1.90	355	134	0.37	1980	19.4	<0.4	<2	10	<0.8	86.4	0.6	0.90	152
	13	23	2.80	22.4	<0.4	2.00	366	142	0.33	2040	20.6	0.4	<2	8	<0.8	92.3	0.7	1.00	157
	13	24	2.89	23.2	0.4	2.00	380	148	0.36	2110	20.9	0.7	<2	9	<0.8	91.8	0.8	1.30	162
	13	25	2.96	22.3	<0.4	1.70	381	143	0.31	2100	20.4	0.8	<2	8	<0.8	95.6	0.7	1.00	157
MEAN(5)	13	24	2.85	22.4	-	1.90	372	142	0.35	2062	20.4	0.8	-	9	-	92.3	0.7	1.04	157
% RECOVERY	-	97	-	85	95	79	85	76	107	81	87	50	-	85	-	82	-	74	89

APPENDIX IVC TRACE METAL CONCENTRATIONS OF STANDARD REFERENCE MATERIALS (BOVINE LIVER AND TORT-1, LOBSTER HEPATOPANCREAS) AND PERCENT RECOVERY BY EP LABORATORY FOR EACH SET OF SAMPLES - JANUARY 1986

	Concentration (µg/g-dry weight)																		
	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	Ti	V	Zn
CRAB SAMPLES FROM BURRARD YARROWS, COAL HARBOUR AND PORT MOODY																			
BOVINE LIVER REFERENCE VALUES																			
MEAN	30	0.053	0.1	0.276	0.24	0.65	189	263	-	587	10.2	3.1	0.4	0.35	0.016	0.22	2	33	132
±95% C.L.	20	0.01	-	0.023	0.06	0.13	21	13	-	20	0.9	0.5	0.4	0.6	-	-	-	-	10
LAB RESULTS																			
	<4	<4	<0.08	0.46	0.6	0.5	165	185	-	598	11.0	3.3	<2	0.60	<0.8	<0.08	<0.2	<0.4	126
	<4	<4	<0.08	0.44	<0.4	0.5	180	192	-	640	11.3	3.3	<2	0.55	<0.8	<0.08	<0.2	<0.4	131
	<4	<4	<0.08	0.46	<0.4	0.6	184	193	-	653	11.3	3.3	<2	0.54	<0.8	<0.08	<0.2	<0.4	133
	<4	<4	<0.08	0.44	<0.4	0.5	174	189	-	621	11.0	3.3	<2	0.52	<0.8	<0.08	<0.2	<0.4	127
	<4	<4	<0.08	0.44	<0.4	0.6	177	196	-	634	11.5	3.0	<2	0.58	<0.8	<0.08	<0.2	<0.4	133
MEAN(5)	-	-	-	0.45	-	0.5	176	191	-	629	11.2	3.2	-	0.56	-	-	-	-	130
% RECOVERY	-	-	-	162	-	83	93	73	-	107	110	105	-	159	-	-	-	-	98
TORT-1 (LOBSTER HEPATOPANCREAS) REFERENCE VALUES																			
MEAN	-	24.6	-	26.3	0.42	2.4	439	186	0.33	2550	23.4	1.5	2.3	10.4	-	11.3	-	1.4	177
±95% C.L.	-	2.2	-	2.1	0.05	0.6	22	11	0.06	250	1	0.3	0.3	2	-	5	-	0.3	10
LAB RESULTS																			
	11	27	3.28	25.7	<0.4	1.8	411	152	0.350	2330	23.1	0.8	3	10	<0.8	108.0	0.5	1.4	166
	13	28	3.07	25.4	<0.4	1.8	385	141	0.371	2200	22.0	0.7	3	10	<0.8	99.7	0.5	1.0	162
	12	29	3.09	25.5	<0.4	1.8	383	158	0.365	2190	23.2	1.5	4	9	<0.8	102.0	0.4	1.0	162
	12	28	3.17	25.5	0.5	2.0	377	159	0.290	2150	22.3	1.0	4	12	<0.8	98.0	0.5	1.0	162
	16	29	3.07	27.0	0.4	1.8	375	145	0.370	2170	23.0	1.0	3	11	<0.8	99.2	0.5	1.3	168
MEAN(5)	13	28	3.14	25.8	0.5	1.8	386	151	0.349	2208	22.7	1.0	3	10	-	101.4	0.5	1.1	164
% RECOVERY	-	115	-	98	107	77	88	81	106	87	97	67	148	100	-	90	-	81	93

APPENDIX IVC TRACE METAL CONCENTRATIONS OF STANDARD REFERENCE MATERIALS (BOVINE LIVER AND TORT-1, LOBSTER HEPATOPANCREAS) AND PERCENT RECOVERY BY EP LABORATORY FOR EACH SET OF SAMPLES - JANUARY 1986

	Concentration (µg/g-dry weight)																		
	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Sn	Sr	Ti	V	Zn
SOLE SAMPLES FROM PEI, PORT MOODY AND CENTRE																			
BOVINE LIVER REFERENCE VALUES																			
MEAN	30	0.053	0.1	0.276	0.24	0.65	189	263	-	587	10.2	3.1	0.4	0.35	0.016	0.22	2	33	132
±95% C.L.	20	0.01	-	0.023	0.06	0.13	21	13	-	20	0.9	0.5	0.4	0.6	-	-	-	-	-
LAB RESULTS																			
	<4	<4	<0.08	0.43	<0.4	0.8	184	202	-	645	10.7	3.3	<2	0.19	<0.8	0.14	<0.2	<0.4	140
	<4	<4	<0.08	0.38	<0.4	0.7	168	185	-	598	9.9	3.0	<2	0.09	<0.8	0.15	<0.2	<0.4	130
	5	4	0.11	0.39	0.7	1.4	177	212	-	641	11.4	4.0	<2	0.09	<0.8	0.14	0.3	1.1	148
	<4	<4	<0.08	0.39	<0.4	0.6	182	192	-	636	10.2	3.1	<2	0.17	<0.8	0.15	<0.2	<0.4	135
	<4	<4	<0.09	0.41	<0.4	0.7	183	196	-	643	10.5	3.1	<2	0.08	<0.9	0.15	<0.2	<0.4	138
MEAN(5)	-	-	-	0.40	-	0.8	179	197	-	633	10.5	3.3	-	0.12	-	0.15	-	-	138
% RECOVERY	-	-	-	145	-	129	95	75	-	108	103	106	-	35	-	66	-	-	105
TORT-1 (LOBSTER HEPATOPANCREAS) REFERENCE VALUES																			
MEAN	-	24.6	-	26.3	0.42	2.4	439	186	0.33	2550	23.4	1.5	2.3	10.4	-	113	-	1.4	177
±95% C.L.	-	2.2	-	2.1	0.05	0.6	22	11	0.06	250	1.0	0.3	0.3	2	-	5	-	0.3	10
LAB RESULTS																			
	11	25	2.97	23.8	<0.4	3.4	411	147	0.48	2240	20.1	0.6	2	8	<0.8	93.8	0.5	1.0	168
	19	25	2.92	28.6	<0.4	1.8	385	180	0.27	2220	22.8	0.4	<2	9	<0.8	96.4	0.3	0.5	190
	11	27	3.13	24.1	<0.4	2.1	436	144	0.24	2360	21.1	0.7	<2	8	<0.8	100.0	0.5	1.0	172
	11	23	2.80	21.6	0.4	1.9	383	153	0.21	2080	18.5	0.7	<2	9	<0.8	87.9	0.4	1.0	155
	12	23	3.00	23.0	<0.4	2.0	405	148	0.25	2220	20.0	0.5	<2	19	<0.8	97.0	0.5	1.1	164
MEAN(5)	13	25	2.96	24.2	-	2.2	404	154	0.29	2224	20.5	0.6	-	11	-	95.0	0.4	0.9	170
% RECOVERY	-	102	-	92	-	92	92	83	88	87	88	40	-	106	-	84	-	64	96

APPENDIX F

VANCOUVER HARBOUR BENTHIC ENVIRONMENTAL QUALITY STUDIES
MAY 1985 - SEPTEMBER 1986

POLYCYCLIC AROMATIC HYDROCARBONS IN SOLE AND CRAB TISSUES

By

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OCTOBER 1989

REVIEW NOTICE

Data reports are prepared to make data available without full analysis or interpretation. This report has been reviewed by the Marine Programs Division, Environmental Protection, and approved for limited distribution. For further information please contact:

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TABLE OF CONTENTS

PAGE

REVIEW NOTICE i
TABLE OF CONTENTS ii
    List of Figures iii
    List of Tables iii
1.0 **INTRODUCTION** 1
2.0 **MATERIAL AND METHODS** 2
    2.1 Study Area 2
    2.2 Field Collection 2
    2.3 Laboratory Analysis 3
3.0 **RESULTS** 6
REFERENCES 11
ACKNOWLEDGEMENTS 12
APPENDIX I Sampling Station Coordinates and Depths -
Vancouver Harbour - January and September 1986 13

LIST OF FIGURES

PAGE

Figure 1 Otter Trawl Locations - Vancouver Harbour 3

LIST OF TABLES

PAGE

Table 1 Tissue Polycyclic Aromatic Hydrocarbon (PAH) Concentrations in Vancouver Harbour - January 1986 7

Table 2 Tissue Polycyclic Aromatic Hydrocarbon (PAH) Concentrations in Vancouver Harbour - September 1986 8

1.0 INTRODUCTION

In May of 1985, Environment Canada began a series of field surveys to determine the benthic environmental quality in Vancouver Harbour. Surface bottom sediments were analyzed for trace metals; particle size, residues, and bacteria content; and selected organic compounds, including polycyclic aromatic hydrocarbons (PAH) (Thomas & Goyette, 1989a, 1989e, and 1989c, respectively). Epibenthic invertebrates and fish were sampled by otter trawl to estimate their abundance and distribution in the harbour (Goyette and Thomas, 1987). Tissues of selected organisms were analyzed for trace metals (Thomas and Goyette, 1989b). Liver tissue and epidermal abnormalities in flatfish were also examined (Goyette et al., 1988).

Since PAH have been found in sediment samples from a number of areas in Vancouver Harbour (Thomas and Goyette, 1989c), the current study proposed to investigate the PAH concentrations in the tissue of two resident species, English sole (Parphyrys vetulus) and Dungeness crab (Cancer magister). Many PAH, generally the high molecular weight compounds, are known or suspected carcinogens (National Academy of Sciences, 1972). Those associated with bottom sediments have been linked to cellular abnormalities in liver tissue and other hepatic lesions in flatfish inhabiting urban areas, such as Puget Sound (Malins et al., 1984).

PAH are highly soluble in lipids and tend to accumulate in fatty tissue. Some fauna, such as fish are capable of converting PAH compounds to metabolites which can escape detection by conventional PAH analysis. Others lack the ability to metabolize PAH and as a result can accumulate PAH in the tissues, particularly species having a high fat content. Although it was considered unlikely that PAH would be found in the fish tissue using routine gas chromatograph/mass spectrophotometer (GC/MS) analysis, liver and muscle samples of English Sole were analyzed for confirmation. In the crab samples, muscle and hepatopancreas tissues were examined, the latter being most likely to accumulate PAH because of its high fat content.

2.0 MATERIALS AND METHODS

2.1 Study Area

Tissue samples for PAH analysis were collected in January and September, 1986 from six sampling stations in Vancouver Harbour as follows:

OUTER HARBOUR - Pacific Environment Institute (PEI)

INNER HARBOUR - Coal Harbour (CH)
- Sterling (ST) (September only)
- Burrard Yarrows (BY) (January only)

EASTERN HARBOUR - Port Moody (PM)(January only)
- Ioco (ICO)

Station locations are shown in Figure 1. Coordinates and depths are provided in Appendix I.

2.2 Field Collection

Tissue samples were collected by fishing a small otter trawl with a 3.8 cm mesh net and a 5.8 m throat from the survey vessel, C.S.S. Vector. The trawl was towed for a distance of approximately 0.9 km at a speed of 1.5 knots. Travl catches were sorted and enumerated by species, and lengths and weights recorded (refer to Goyette and Thomas, 1987). Fish were held in live tanks and tissue samples were taken immediately after each trawl using heat treated stainless steel scalpels and forceps. Samples were frozen individually in heat treated aluminum foil until analyzed. Tissue samples were as follows:

English sole: liver (whole); dorsal muscle (with skin and bone removed).
Crab: leg and claw muscle; hepatopancreas (composites of two)

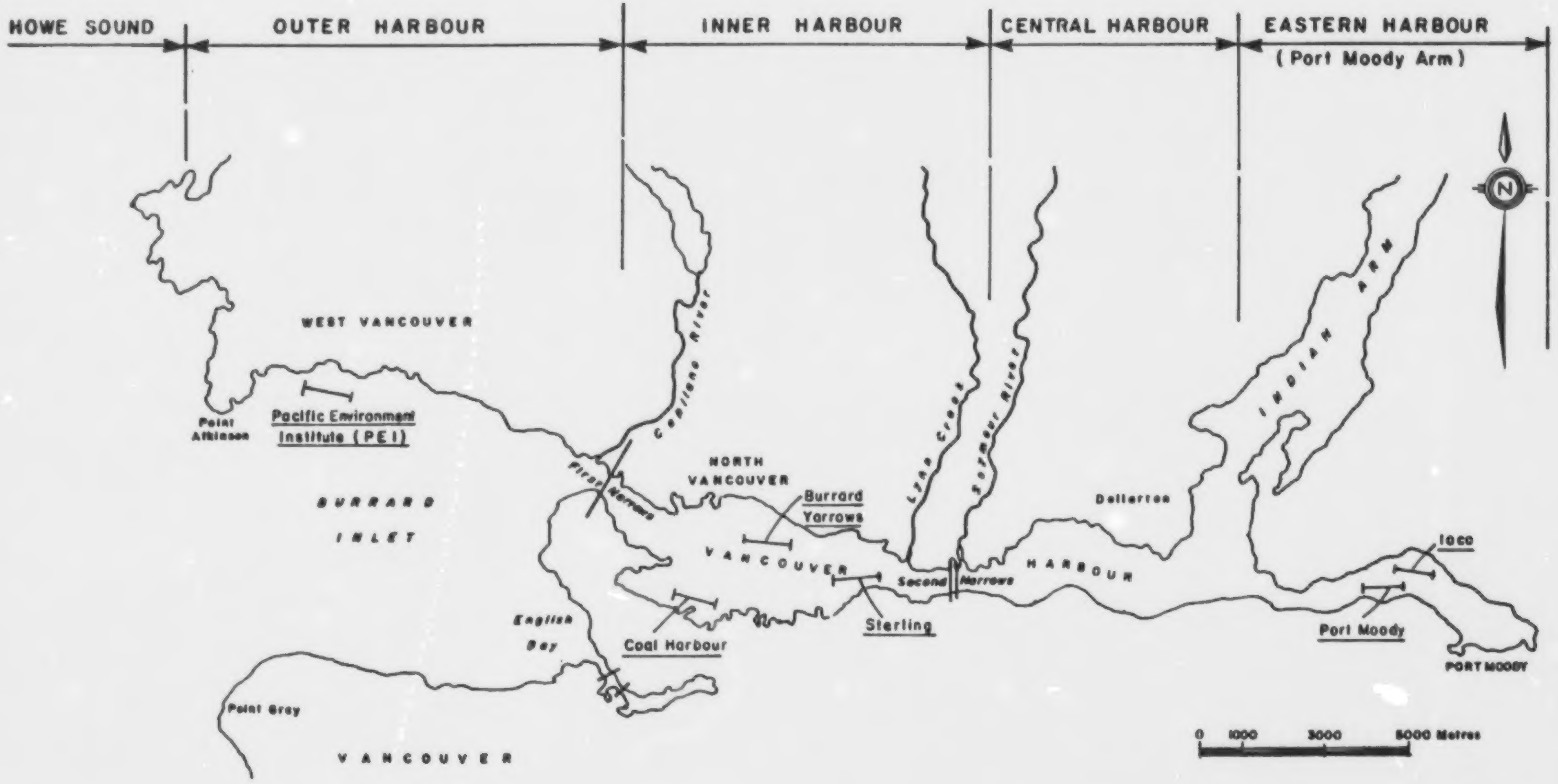
HOWE SOUND
OUTER HARBOUR
INNER HARBOUR
CENTRAL HARBOUR
EASTERN HARBOUR
(Port Moody Arm)
N
WEST VANCOUVER
Point Atkinson
Pacific Environment Institute (PEI)
BURRARD INLET
Capilano River
First Narrows
NORTH VANCOUVER
Burrard Yarrows
VANCOUVER
English Bay
Coal Harbour
Sterling
Lynn Creek
Seymour River
Second Narrows
HARBOUR
Dollarton
INDIAN ARM
Ioco
Port Moody
PORT MOODY
Point Grey
VANCOUVER
0 1000 3000 5000 Metres

FIGURE I OTTER TRAWL LOCATIONS - VANCOUVER HARBOUR (1985-1986)

2.3 Laboratory Analysis

Eleven tissue samples from the January 1986 survey and 44 samples from the September 1986 survey were sent to external laboratories for analysis. The January samples were analyzed by a different laboratory than those in September.

The January 1986 samples were digested with ethanolic KOH and extracted with hexane. Extract aliquots of 40 µl (equivalent to 1 gram of fish tissue) were injected into a Waters high pressure liquid chromatography (HPLC) system equipped with a fluorescence detector and a WISP automatic sampler. The PAH compounds were eluted through a gradient of acetonitrile and water on the chromatographic column.

The September 1986 samples were extracted, fractionated using adsorption techniques, and analyzed by gas chromatographic/mass selection detection (GC/MSD). Selection ion monitoring (SIM) was employed to increase sensitivity and selectivity. This was necessary to achieve maximum detection limits for small quantities of tissue (1 to 10 grams).

Two blind splits from the January samples and 9 from the September survey were included with the test samples to check quality control of the external laboratories. In addition, the laboratories perform internal lab duplicates for verification. For the January samples, one internal lab duplicate (A & B) was analysed. For the September samples, internal quality control was maintained using method blanks and analyzing internal duplicates (A & B), which were chosen independently by the laboratory. In addition, each sample was spiked with 3 surrogate PAH compounds (naphthalene-d8, acenaphthene-d10, and 2-fluorbiphenyl) and quality control accuracy data were produced for each surrogate compound as follows:

Compound Standard	Mean Recovery	Standard Deviation	Relative Deviation
Naphthalene-d8	41.6%	11.7%	28%
Acenaphthene-d10	61.5%	11.8%	19.3%
2-Fluorbiphenyl	53.5%	8.7%	16.3%

Median detection limits for the January 1986 samples were reported between .001 µg/g and .060 µg/g. A general detection limit of 0.01 µg/g was reported for each target PAH compound found in the September samples using 1 to 10 grams of tissue and 500 µl final volume. In both cases, amounts less than the detection limits but present in the sample, were reported as "trace" concentrations.

3.0 RESULTS

Tissue PAH levels of Dungeness crab and English sole sampled are provided in Tables 1 and 2, including the results from blind splits and any internal laboratory duplicates that were analyzed for quality control.

PAH compounds were detected in all but one tissue sample collected in January 1986. However, this data is questionable because agreement between blind split replicates was poor. In crab hepatopancreas tissue, concentrations were highest at Port Moody, with 0.830 µg/g phenanthrene and 0.325 µg/g fluoranthene reported by the laboratory. Concentrations were lower in English sole liver, with the highest concentrations, 0.037 µg/g phenanthrene and 0.074 µg/g fluoranthene, detected at the PEI station. English sole muscle PAH concentrations were either trace or not detected.

PAH compounds were not detected in English sole liver or muscle tissue in September 1986. Higher levels were detected in crab hepatopancreas tissues than in crab muscle tissues. The maximum levels for September 1986 were detected in a sample of hepatopancreas tissue from Coal Harbour, with 0.17 µg/g anthracene/phenanthrene and 0.16 µg/g fluoranthene.

TABLE 1 TISSUE POLYCYCLIC AROMATIC HYDROCARBON (PAH) CONCENTRATIONS - VANCOUVER HARBOUR - January 1986

STATION	CONCENTRATION (UG/G DRY WEIGHT)												
	NAPTHALENE	ACENAPHTHYLENE	ACENAPHTHENE	ANTH./ PHEN.	FLUORENE	FLUORANTHENE	PYRENE	CHRYSENE/ BENZO(a) ANTHRACENE	B(k)/B(b) FLUORANTHENE	BENZO(a) PYRENE	BENZO (ghi) PERYLENE	DiBENZO (ah) ANTHRACENE	INDENO (1,2,3cd) PYRENE
DUNGENESS CRAB - HEPATOPANCREAS													
COAL HARBOUR (CH)	-	-	-	.001/.037	<.06	<.010	.036	.017/.010	TRACE/.008	<.005	<.020	<.060	<.060
BURRARD YARROWS (BY)													
LAB DUPLICATE-A	-	-	-	<.001/.014	<.06	<.010	<.010	TRACE/<.001	<.005/<.005	TRACE	<.020	<.060	<.060
LAB DUPLICATE-B	-	-	-	<.001/.019	<.06	.027	<.010	TRACE/TRACE	<.005/TRACE	<.005	<.020	<.060	<.060
PORT MOODY (PM)	-	-	-	<.001/.830	<.06	.325	<.010	<.010/<.001	.008/.047	<.005	<.020	.142	<.060
ENGLISH SOLE - LIVER													
PACIFIC ENVIRONMENT INSTITUTE (PEI)													
BLIND SPLIT-1	-	-	-	<.001/<.01	<.06	<.010	<.010	<.010/<.001	<.005/<.005	<.005	<.020	<.060	<.060
BLIND SPLIT-2	-	-	-	.001/.037	<.06	.074	.042	.027/TRACE	.012/.024	TRACE	<.020	<.060	<.060
COAL HARBOUR (CH)	-	-	-	.001/.014	<.06	.013	<.010	<.010/<.001	<.005/<.005	<.005	<.020	<.060	<.060
BURRARD YARROWS (BY)	-	-	-	<.001/TRACE	<.06	.013	<.010	<.010/<.001	<.005/TRACE	<.005	<.020	<.060	<.060
PORT MOODY (PM)	-	-	-	- /.019	<.06	-	<.010	<.010/<.001	<.005/<.005	<.005	<.020	<.060	<.060
ENGLISH SOLE - MUSCLE													
PORT MOODY (PM)													
BLIND SPLIT	-	-	-	<.001/TRACE	<.06	<.010	<.010	<.010/<.001	<.005/<.005	<.005	<.020	<.060	<.060
BLIND SPLIT	-	-	-	<.001/TRACE	<.06	.013	<.010	<.010/<.001	<.005/<.005	<.005	<.020	<.060	<.060
IOCO (ICO)	-	-	-	<.001/TRACE	<.06	<.010	<.010	<.010/<.001	<.005/<.005	<.005	<.020	<.060	<.060

TABLE 2 TISSUE POLYCYCLIC AROMATIC HYDROCARBON (PAH) CONCENTRATIONS - VANCOUVER HARBOUR - September 1986

	CONCENTRATION (ug/g DRY WEIGHT)												
STATION REPLICATE	NAPTHAL-ENE	ACENAPH-THYLENE	ACENAPH-THENE	ANTH./ PHEN.	FLUORENE	FLUOR-ANTHENE	PYRENE	CHRYSENE/ B(a)ANTH.	B(k)/B(b) FLUORANTHENE	BENZO(a) PYRENE	BENZO (ghi) PERYLENE	DiBENZO (ah)ANTH-RACENE	INDENO (1,2,3cd) PYRENE
DUNGENESS CRAB - HEPATOPANCREAS													
PACIFIC ENVIRONMENT INSTITUTE (PEI)													
1 LAB DUPLICATE-A	<.01	<.01	<.01	.01	<.01	.01	TRACE	TRACE	TRACE	TRACE	TRACE	<.01	<.01
LAB DUPLICATE-B	<.01	<.01	<.01	.01	<.01	.01	TRACE	TRACE	TRACE	TRACE	TRACE	<.01	<.01
2 LAB DUPLICATE-A	<.01	<.01	<.01	TRACE	<.01	.01	TRACE	TRACE	TRACE	TRACE	TRACE	<.01	<.01
LAB DUPLICATE-B	<.01	<.01	<.01	TRACE	<.01	.01	TRACE	TRACE	TRACE	TRACE	TRACE	<.01	<.01
3 LAB DUPLICATE-A	<.01	<.01	<.01	TRACE	<.01	.01	TRACE	TRACE	TRACE	TRACE	TRACE	<.01	<.01
LAB DUPLICATE-B	<.01	<.01	<.01	.01	<.01	.02	.01	.01	.01	TRACE	TRACE	<.01	<.01
BLIND SPLIT	<.01	<.01	<.01	.01	<.01	.03	.01	TRACE	TRACE	TRACE	TRACE	<.01	<.01
COAL HARBOUR (CH)													
1 BLIND SPLIT	<.01	<.01	<.01	.02	<.01	.02	.02	<.01	<.01	<.01	<.01	<.01	<.01
BLIND SPLIT	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01
2 LAB DUPLICATE-A	<.01	<.01	<.01	.03	<.01	.06	.04	.02	.01	.01	<.01	<.01	<.01
LAB DUPLICATE-B	<.01	<.01	<.01	.04	<.01	.06	.04	.02	.01	.01	<.01	<.01	<.01
3	<.01	<.01	<.01	.17	.05	.16	.10	.02	.01	.01	TRACE	<.01	<.01
STERLING (ST)													
1 BLIND SPLIT	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01
BLIND SPLIT	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01
2 LAB DUPLICATE-A	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01
LAB DUPLICATE-B	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01

TABLE 2 (CONT'D) TISSUE POLYCYCLIC AROMATIC HYDROCARBON (PAH) CONCENTRATIONS - VANCOUVER HARBOUR - September 1986

STATION	CONCENTRATION (ug/g DRY WEIGHT)												
	NAPTHAL-ENE	ACENAPH-THYLENE	ACENAPH-THENE	ANTH./ PHEN.	FLUORENE	FLUOR-ANTHENE	PYRENE	CHRYSENE/ B(a)ANTH.	B(k)/B(b) FLUORANTHENE	BENZO(a) PYRENE	BENZO (ghi) PERYLENE	DiBENZO (ah)ANTH-RACENE	INDENO (1,2,3cd) PYRENE
IOCO (ICO)													
1	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01
2	<.01	<.01	<.01	<.01	<.01	TRACE	TRACE	TRACE	<.01	<.01	<.01	<.01	<.01
3	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01
DUNGENESS CRAB - MUSCLE													
IOCO (ICO)													
1	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01
2 BLIND SPLIT	<.01	<.01	<.01	.02	<.01	.02	.01	TRACE	<.01	<.01	<.01	<.01	<.01
BLIND SPLIT	<.01	<.01	<.01	.02	<.01	.03	.02	TRACE	<.01	<.01	<.01	<.01	<.01
3 BLIND SPLIT	<.01	<.01	<.01	.01	<.01	TRACE	TRACE	<.01	<.01	<.01	<.01	<.01	<.01
BLIND SPLIT	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01
ENGLISH SOLE - LIVER													
PACIFIC ENVIRONMENT INSTITUTE (PEI)													
1 to 5 (INCLUDES 1 BLIND SPLIT)	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01
COAL HARBOUR (CH)													
1 to 6	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01

TABLE 2 (CONT'D) TISSUE POLYCYCLIC AROMATIC HYDROCARBON (PAH) CONCENTRATIONS - VANCOUVER HARBOUR - September 1986

STATION	CONCENTRATION (ug/g DRY WEIGHT)												
	NAPTHAL-ENE	ACENAPH-THYLENE	ACENAPH-THENE	ANTH./ PHEN.	FLUORENE	FLUOR-ANTHENE	PYRENE	CHRYSENE/ B(a)ANTH.	B(k)/B(b) FLUORANTHENE	BENZO(a) PYRENE	BENZO (ghi) PERYLENE	DiBENZO (ah)ANTH-RACENE	INDENO (1,2,3cd) PYRENE
IOCO (ICO)													
1 to 6 (INCLUDES 1 BLIND SPLIT)	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01
ENGLISH SOLE - MUSCLE													
IOCO (ICO)													
1 to 3 INCLUDES 2 BLIND SPLITS)	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01

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APPENDIX I SAMPLING STATION COORDINATES AND DEPTHS - VANCOUVER HARBOUR - JANUARY AND SEPTEMBER 1986

SURVEY DATE	STATION	START			FINISH		
		DEPTH	LATITUDE	LONGITUDE	DEPTH	LATITUDE	LONGITUDE
JANUARY 1986	PEI	66	49°19.76′N	123°14.39′W	56	49°19.75′N	123°13.67′W
	BURRARD YARROWS	27	49°18.23′N	123°05.26′W	25	49°18.25′N	123°04.47′W
	COAL HARBOUR	21	49°17.49′N	123°06.10′W	12	49°17.53′N	123°06.76′W
	PORT MOODY	14	49°17.60′N	122°53.68′W	17	49°17.52′N	122°54.45′W
	IOCO	13	49°17.75′N	122°53.61′W	10	49°17.94′N	122°52.90′W
SEPTEMBER 1986	PEI	64	49°19.86′N	123°13.92′W	50	49°19.86′N	123°13.16′W
	COAL HARBOUR	24	49°17.48′N	123°05.93′W	12	49°17.55′N	123°06.68′W
	STERLING	24	49°17.55′N	123°04.12′W	33	49°17.73′N	123°09.45′W
	IOCO	10	49°17.93′N	122°52.88′W	14	49°17.75′N	123°53.60′W

APPENDIX G

FURTHER STUDIES ON THE PREVALENCE OF IDIOPATHIC LIVER LESIONS IN ENGLISH SOLE, *PAROPHRYS VETULUS*, FROM VANCOUVER HARBOUR, BRITISH COLUMBIA, 1987

By

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D. Goyette

October 1989

REVIEW NOTICE

This report has been reviewed and approved for limited publication by the Marine Programs Division, Environmental Protection. Histological analysis was completed under contract to D. Brand, University of Victoria. Readers may direct comments or questions to:

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TABLE OF CONTENTS

PAGE

REVIEW NOTICE i
TABLE OF CONTENTS ii
  List of Tables iii
  List of Figures iii
  List of Plates iv
SUMMARY v
1.0 INTRODUCTION 1
2.0 MATERIALS AND METHODS 4
  2.1 Sample Collection 4
  2.2 Histological Preparation 4
3.0 RESULTS AND DISCUSSION 5
  3.1 Histopathology 5
    3.1.1 Normal Liver Structure 5
    3.1.2 Idiopathic Liver Lesions 5
  3.2 Prevalences of Idiopathic Liver Lesions 7
PLATES 12
REFERENCES 23
ACKNOWLEDGEMENTS 24
APPENDIX I Gross Morphology, Histopathology, and Parasitic Result of English Sole Liver Examinations 25

LIST OF TABLES

		PAGE
Table 1	Prevalences of Preneoplastic and Neoplastic Liver Lesions in English Sole from Vancouver Harbour - 1986 and 1987	8
Table 2	Percent Frequency of Individual Idiopathic Liver Lesions Occurring in English Sole from Vancouver Harbour (1986 and 1987) and Eagle Harbour (Puget Sound) Including Neoplasms, Preneoplasms, and Megalocytic Hepatosis	10

LIST OF FIGURES

		PAGE
Figure 1	Study Areas - Vancouver Harbour and Reference Site, Loughborough Inlet	2
Figure 2	Otter Trawl Locations - Vancouver Harbour	3
Figure 3	Prevalences of Preneoplastic and Neoplastic Liver Lesions Found in English Sole from Vancouver Harbour and the Reference Site, Loughborough Inlet - 1987	9

LIST OF PLATES

PAGE

ENGLISH SOLE LIVER TISSUE MICROGRAPHS

Plate 1 Normal Liver Tissue 13

Plate 2 Zooparasitic Infection (Myxidium sp.) 13

Plate 3 Zooparasitic Infection (External Parasite) 13

Plate 4 Zooparasitic Infection (Helminth) 13

Plate 5 Nonspecific Necrotic Lesion 15

Plate 6 Intracytoplasmic Storage Disorder (Hepatocellular Hemosiderosis) 15

Plate 7 Intracytoplasmic Storage Disorder (Hepatocellular Hemosiderosis).. 15

Plate 8 Specific Degenerative Condition (Megalocytic Hepatosis).. 15

Plate 9 Foci of Cellular Alteration (Clear Cell Foci) 17

Plate 10 Foci of Cellular Alteration (Eosinophilic Foci)......... 17

Plate 11 Foci of Cellular Alteration (Basophilic Foci) 17

Plate 12 Foci of Cellular Alteration (Basophilic Foci) 17

Plate 13 Liver Cell Adenoma (Clear Cell Type) 19

Plate 14 Liver Cell Adenoma (Eosinophilic Type) 19

Plate 15 Liver Cell Adenoma (Basophilic Type) 19

Plate 16 Liver Cell Adenoma (Mixed Type) 19

Plate 17 Hepatocellular Carcinoma 21

Plate 18 Hepatocellular Carcinoma (Higher Magnification) 21

Plate 19 Cholangiofibrosis 21

Plate 20 Cholangiofibrosis (Higher Magnification) 21

SUMMARY

1. As in 1986, idiopathic liver lesions (nonparasitic, noninfectious) were observed in English sole (Parophrys vetulus) collected from Vancouver Harbour. They were absent in the same species sampled from a relatively undisturbed coastal reference site, Loughborough Inlet.

2. The types of idiopathic liver lesions observed included: nonspecific necrosis; megalocytic hepatosis, a specific degenerative condition; hepatocellular steatosis and hemosiderosis, intracytoplasmic storage disorders; foci of cellular alteration (clear cell, eosinophilic, and basophilic foci), preneoplastic lesions; hepatocellular carcinoma and liver cell adenoma, neoplasms; and cholangiofibrosis, a nonneoplastic proliferative condition.

3. Compared with the previous year, there was an increase in the types of idiopathic liver lesions observed in English sole. In addition to the lesions reported in the 1986 study, hepatocellular hemosiderosis, hepatocellular carcinoma, and cholangiofibrosis were detected in 1987. Modifications to the histochemical staining procedure and an increase in the sample size may, in part, have contributed to the increase in lesions in the second year.

4. As in the previous study, the prevalence of idiopathic liver lesions was dependent on sampling location. The highest prevalence of preneoplasms and neoplasms (75.0%) was again found at the Ioco station in Port Moody Arm. This percentage was significantly higher than those at the other sampling stations in Vancouver Harbour. Noteably, the water in the inlet is poorly circulated and elevated hydrocarbon (including polycyclic aromatic hydrocarbons) and certain trace metal levels have been observed. Moderate idiopathic lesion prevalences of 35.0% and 26.3% were found in liver specimens collected closer to the mouth of Port Moody Arm (Port Moody station) and in the inner harbour (Centre station), respectively. Only 5% occurred in the outer harbour (Pacific Environment Institute station).

5. Idiopathic liver lesions found in Vancouver Harbour English sole resemble the types and freqencies of those observed in the same species from Eagle Harbour, an urban industrial area in Puget Sound, Washington.

6. The present study substantiates the results of the previous 1986 study, reaffirming the potential value of histopathological analysis in assessing the effects from anthropogenic chemicals exposure in Vancouver Harbour.

1.0 INTRODUCTION

Studies in Puget Sound have shown a positive link (by association) between histopathological conditions in demersal fish and xenobiotic chemicals found in sediments near urban and industrial centres (Myers et al., 1987; Malins and Hodgins, 1984; Malins et al., 1984). In particular, high lesion prevalences have been observed in the livers of flatfish from areas receiving industrial effluent.

Histopathological analyses of flatfish collected from Vancouver Harbour in 1986, primarily English sole (Parophrys vetulus), revealed that the prevalence of idiopathic liver lesions (noninfectious, nonparasitic) was strongly dependent on location of capture (Brand, 1987; Goyette et al., 1988). Fish caught in Port Moody Arm showed the highest prevalence of one or more types of preneoplastic and neoplastic liver lesions. There were moderate prevalences along the north and south shores of the inner harbour while lower prevalences occurred in the centre of the channel. The station along the West Vancouver shore also showed a relatively low prevalence of liver lesions.

The current study was undertaken in 1987 to confirm the findings of the original study of 1986 (Goyette et al., 1988). English sole remained the target species due to their relative abundance and sensitivity to idiopathic liver lesion development (Myers et al., 1987). In addition to Vancouver Harbour, Loughborough Inlet was included in the study as a reference site (Figure 1). It is a coastal fjord, located north along B.C. coast between Knight and Bute inlets, relatively undisturbed by human activites. Four of the seven Vancouver Harbour stations surveyed in 1986 were reassessed: Pacific Environment Institute station in the outer harbour; Centre station in the inner harbour; and Port Moody and Ioco stations in Port Moody Arm (Figure 2). The outer harbour is influenced by the Fraser River, Howe Sound, and the outflow from Vancouver Harbour while Port Moody Arm is characterized by poor water circulation. It should be noted that station names were selected by location and do not imply a principal source of chemical pollution or cause of idiopathic liver lesions.

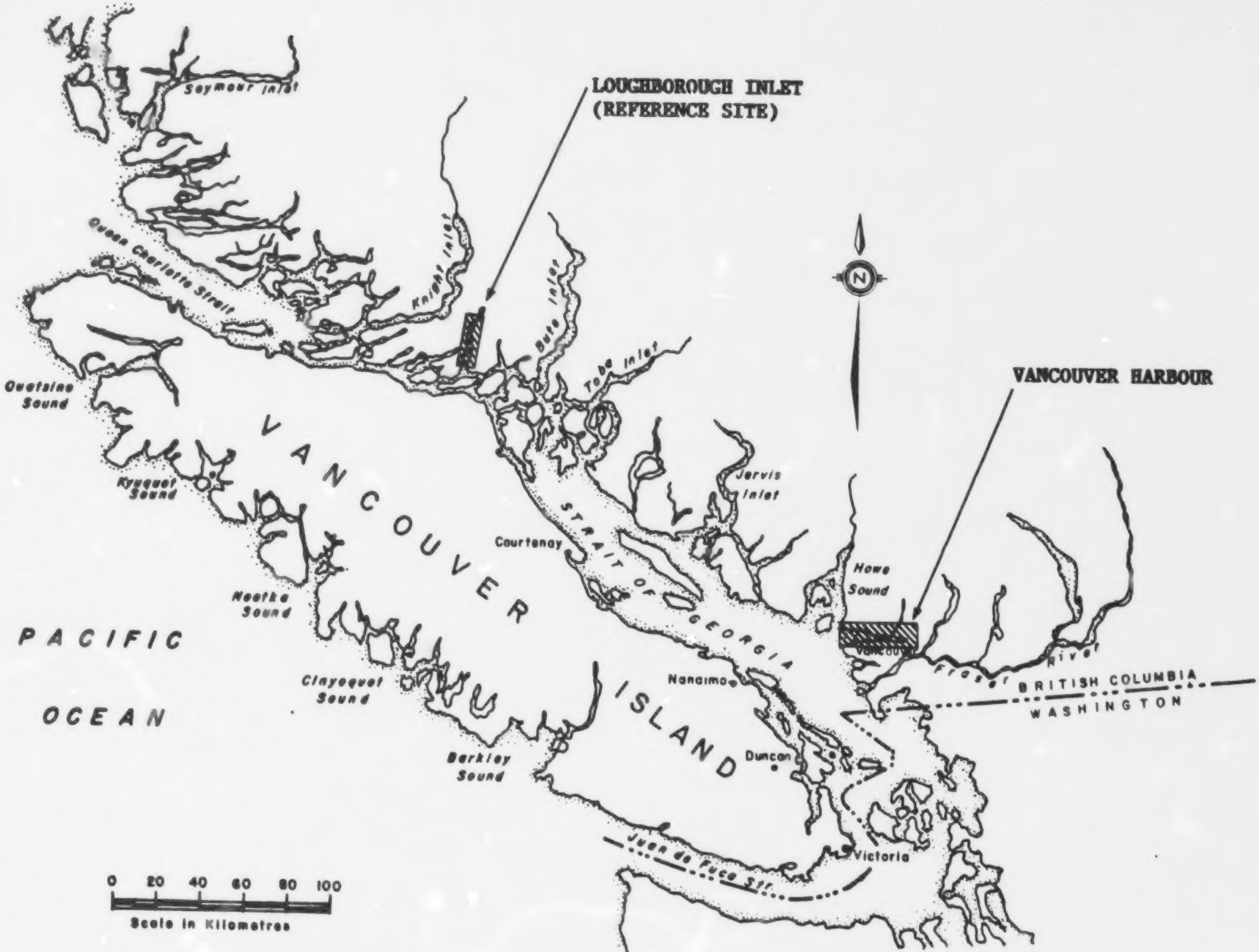

LOUGHBOROUGH INLET
(REFERENCE SITE)
VANCOUVER HARBOUR
N
Seymour Inlet
Queen Charlotte Strait
Knight Inlet
Bute Inlet
Toba Inlet
Jervis Inlet
Howe Sound
Vancouver
Fraser River
BRITISH COLUMBIA
WASHINGTON
STRAIT OF GEORGIA
Courtenay
Nanaimo
Duncan
Victoria
Juan de Fuca Str.
VANCOUVER ISLAND
Quatsino Sound
Kyuquot Sound
Nootka Sound
Clayoquot Sound
Barkley Sound
PACIFIC OCEAN
0
20
40
60
80
100
Scale in Kilometres

FIGURE 1 VANCOUVER HARBOUR STUDY AREA AND REFERENCE SITE LOUGHBOROUGH INLET

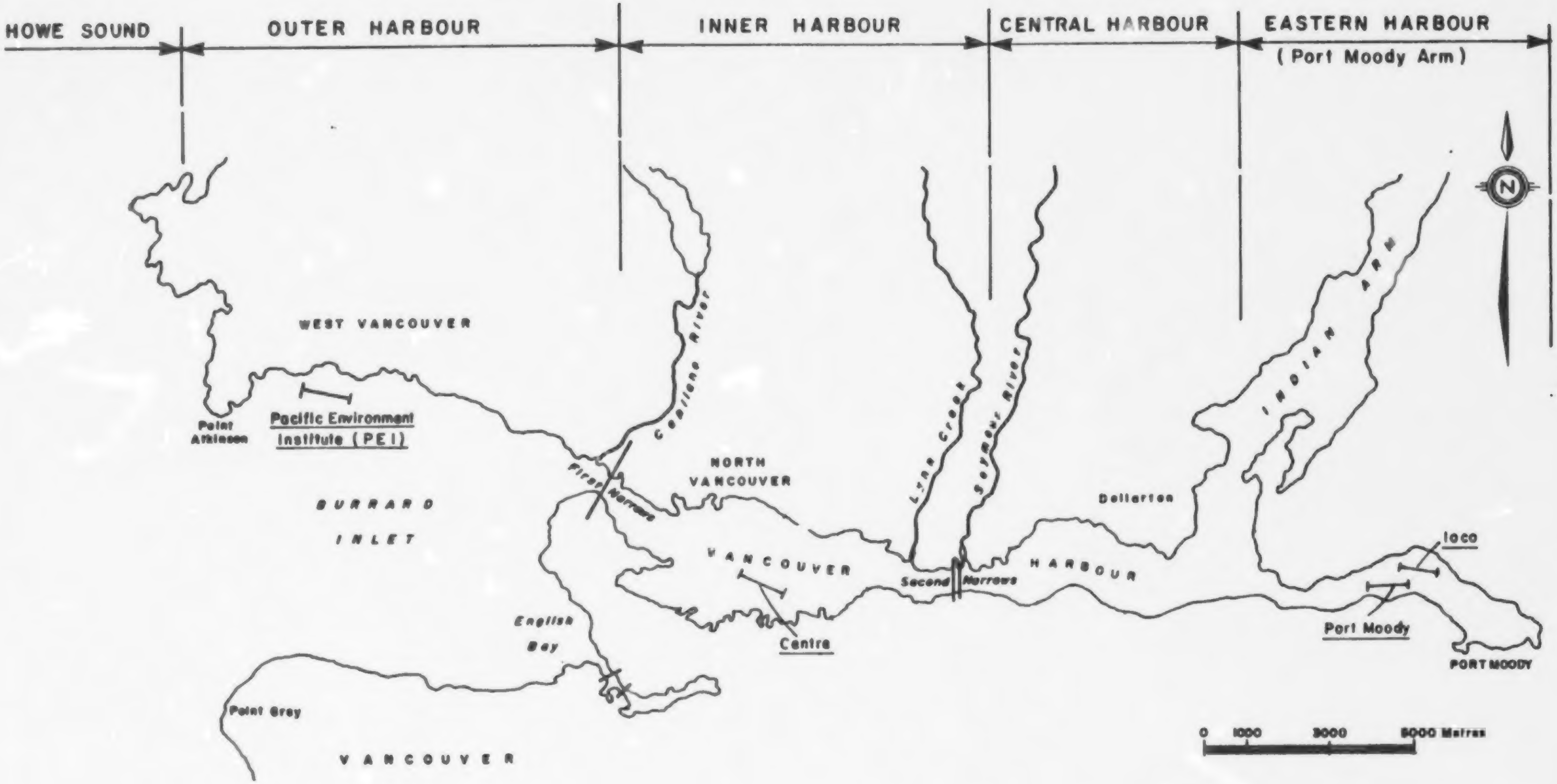

HOWE SOUND
OUTER HARBOUR
INNER HARBOUR
CENTRAL HARBOUR
EASTERN HARBOUR
(Port Moody Arm)
N
WEST VANCOUVER
Point Atkinson
Pacific Environment Institute (PEI)
BURRARD INLET
Capilano River
First Narrows
NORTH VANCOUVER
VANCOUVER
Centre
English Bay
Point Grey
VANCOUVER
Lynn Creek
Seymour River
Second Narrows
HARBOUR
Dollarton
INDIAN ARM
Ioco
Port Moody
PORT MOODY
0
1000
3000
5000 Metres

FIGURE 2 OTTER TRAWL LOCATIONS - VANCOUVER HARBOUR

2.0 MATERIALS AND METHODS

2.1 Sample Collection

Using the research vessel, C.S.S. Vector, as a sampling platform, English sole were collected by otter trawl from Loughborough Inlet and Vancouver Harbour on July 9, 1987 and October 27-30, 1987, respectively. The net was a 3.8 cm mesh with a 5.8 m throat. Trawls were towed with a 2.5:1 scope (wire length:depth) at approximately 1.5 knots for an average distance of 0.5 nautical miles, as determined by radar bearings. Fish specimens were held in live tanks with running seawater for a maximum of one hour prior to dissection. Total fork length was measured and the livers were excised and fixed in 10% buffered formalin. Fixed tissues were shipped to Victoria for histopathological analysis.

2.2 Histological Preparation

While in the fixative, tissue samples were excised from the central portion of the liver along the longitudinal axis to include the anterior and posterior lobes. Each liver sample was divided into two equal parts to permit proper penetration of histological solutions, and histological sectioning of representative areas of the liver. Following fixation, tissues were washed in water, dehydrated in ethanols, cleared in xylene and embedded in paraffin (Paraplast). Skip serial sections (7 µm) were cut using a Sorval JB4 porter-blum microtome and stainless steel knives. Slides were stained by Delafield's haematoxylin and eosin (H&E) for general histology, Periodic Acid Shiff (PAS) for glycoproteins and mucopolysaccharides (Humason, 1979), and Perls' method (Prussian blue) for ferric iron (Pearce, 1972). Liver abnormalities were classified using nomenclature consistent with Myers et al. (1987) and documented on light micrographs from a Zeiss ultraphot microscope on t-max 100 black and white film. To eliminate bias, sources of samples were unknown to the histologist during the analysis.

3.0 RESULTS AND DISCUSSION

3.1 Histopathology

Histopathological observations (gross morphology, histopathology and parasites) of English sole livers and corresponding fork lengths of the fish are given in Appendix I.

3.1.1 Normal Liver Structure

The number of English sole with normal liver tissue varied among the sampling sites (Appendix I). A light micrograph of normal liver tissue is presented in Plate 1. Lesions and granulomas were present within normal liver tissue due to parasitic infections by Myxidium (Plate 2), nematodes (Plate 3), and helminths (Plate 4). The degree of cellular vacuolation varied among samples as did the tinctorial characteristics of the hepatocellular cytoplasm. For descriptive details of normal English sole liver structure refer Myers et al. (1987) or brief descriptions in Brand (1987) and Goyette et al. (1988).

3.1.2 Idiopathic Liver Lesions

Using the classfication adopted by Myers et al. (1987), the idiopathic lesions observed in Vancouver Harbour English sole were as follows:

a) Nonspecific necrotic lesions (Plate 5);

b) Intracytoplasmic storage disorders - hepatocellular steatosis and hemosidersis (Plates 6 & 7);

c) Specific degenerative conditions - megalocytic hepatosis (Plate 8)

d) Foci of cellular alteration - clear cell, eosinophilic and basophilic foci (Plates 9 - 12);

e) Neoplasms - liver cell adenomas and hepatocellular carcinomas (Plates 13 - 18); and

f) Nonneoplastic proliferative conditions - cholangiofibrosis (Plates 19 and 20)

In addition to the lesions found in the 1986 survey, hepatocellular carcinomas, hepatocellular hemosiderosis, and cholangiofibrosis, were observed in 1987. The liver lesion types common to both studies have been described in the previous study (Goyette et al. 1988). The histological and histochemical descriptions used in these reports were taken from Myers et al. (1987) based on studies of English sole in Puget Sound. This reference should be referred for specific details. The three lesions types additional to the current study have been described as follows.

Hepatocellular hemosiderosis was observed in fish liver samples from all stations, including the reference site in Loughborough Inlet. It is an intracytoplasmic storage disorder characterized by an excessive accumulation of iron within the hepatocytes (Myers et al., 1987). This condition was recognized following histochemical treatment for iron using Prussian blue (Plate 6). It may have been present in the 1986 samples but the sections were not treated for iron. Myers et al. (1987) noted a weak association between hemosiderosis and the preneoplastic lesions, eosinophilic and basophilic foci, however to date they have not shown this disorder has not been experimentally induced in fish by hepatocarcinogens-hepatotoxins.

Hepatocellular carcinoma is a neoplastic lesion found in sole well into their second year of life (Myers et al., 1987). Based on Myers et al. (1987), it was distinguished by atypical cellular morphology distinguished by significant compression and invasion of the adjacent tissue. The nodules display irregular borders and there was a relative absence of other hepatic elements. The muralial architecture was primarily trabecular, with thickened cords and disorganized muralial patterns. Cells composing these neoplasms were polygonal, pleomorphic and anaplastic 17 & 18). Cytoplasmic iron was reduced and dense PAS positive material was found within the carcinomas.

Hepatocellular carcinoma was found only in English sole collected from the Ioco sampling site. It was not observed in the 1986 samples. An increase number of large size class sole (mean fork length 33 cm), more liver sections analyzed, and improved histochemical procedures may have increased the chances of observing this lesion. Intrahepatic spread of hepatocellular carcinoma was evident by multiple morphologically-identical tumors seen in a single English sole liver. This spread was also observed in samples with liver cell adenomas.

Cholangiofibrosis was the third type of idiopathic lesion observed in Vancouver Harbour English sole livers for the first time. Its presence in the 1986 samples may have been overlooked due to the smaller sample size and fewer liver section examined but this is only speculation. It was found only in the Ioco station fish which showed various types of cellular abnormalities. As described in Myers et al. (1987), cholangiofibrosis is distinguished by a proliferation of dilated cystic tubular structures resembling bile ducts, often with numerous papillary regions and embedded within a dense fibrous encapsulating stroma (Plates 19 & 20). The tubular lumina often contain PAS positive material. Cholangiofibrosis is considered to be a nonneoplastic proliferative lesion due to the extent of associated fibrosis and the degree of encapsulation delimiting growth, and not involved in the progression toward neoplasia (Myers et al., 1987). Although it has not been experimentally induced in fish by xenobiotic carcinogenic chemicals, it has in rodents (Myers et al., 1987).

3.2 Prevalences of Idiopathic Liver Lesions

The number of idiopathic lesion types found in English sole from Vancouver Harbour increased between 1986 and 1987 (Table 1). Preneoplastic (clear cell, basophilic, and eosinophilic foci) and neoplastic (liver cell adenomas and hepatocellular carcinomas) lesions were the only idiopathic types used to calculate the frequency of occurrence. The other lesions were omitted due to their uncertain link to xenobiotic carcinogenic chemical exposure.

The 1987 data verified that prevalence of English sole with neoplastic and preneoplastic liver lesions was strongly dependent on location of capture

TABLE 1 PREVALENCES OF PRENEOPLASTIC[1] AND NEOPLASTIC[2] LIVER LESIONS IN ENGLISH SOLE FROM VANCOUVER HARBOUR - 1987 and 1986[3].

STATION	1987			1986		
	n	Number with Neoplasms/ Preneoplasms	%	n	Number with Neoplasms/ Preneoplasms	%
Pacific Environment Institute	20	1	5.0	15	2	13.3
Centre Channel	19	5	26.3	12	2	8.3
Port Moody	20	7	35.0	–	–	–
Ioco	16	12	75.0	17	10	58.8
Coal Harbour	–	–	–	10	2	20.0
Burrard Yarrows	–	–	–	10	3	30.0
Loughborough Inlet (Reference Site)	5	0	0	–	–	–
	80	25		64	19	

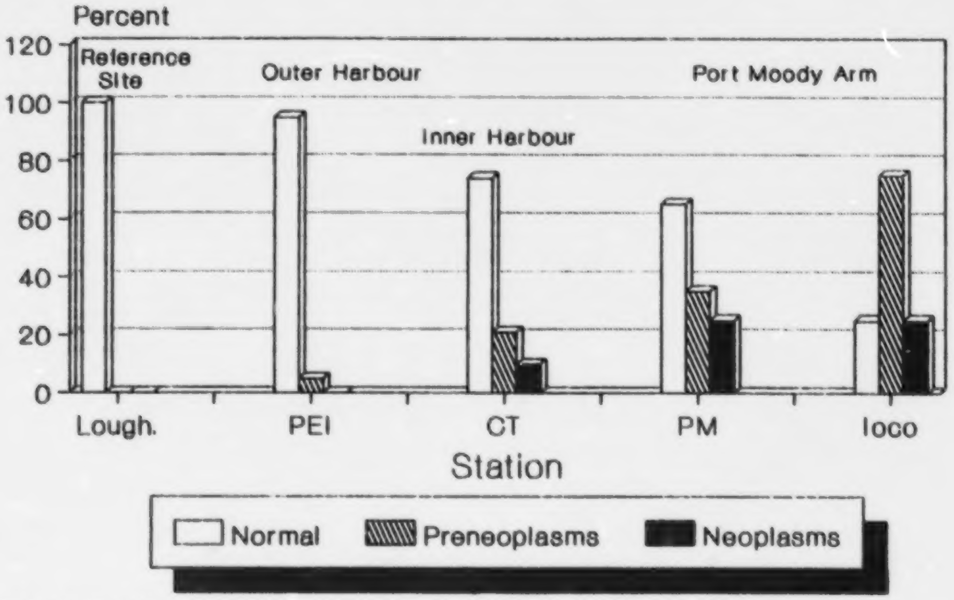
---

[1] Preneoplastic lesions (preneoplasms) include foci of cellular alterations (clear cell, eosinophilic and basiophilic foci).

[2] Neoplastic lesions (neoplasms) include hepatocellular carcinomas and liver cell adenomas.

[3] Date from Goyette et al. (1988)

(chi square = 24.2, df = 4, P>0.001). The Ioco trawl station in Port Moody Arm had the highest prevalence with 75.0% of the fish affected, up from 58,8% in 1986 (Table 1). The Port Moody station, near the mouth of the arm, and Centre station in the inner harbour, followed with prevalences of 35.0% and 26.3%, respectively. The lowest percentages (5.0% and 0%) were observed at the Pacific Environment Institute station and the reference site (Loughborough Inlet), respectively. Of the total number of sole sampled in Vancouver Harbour, 33% (25 out of 75) were affected by either preneoplastic or neoplastic lesions. The percentages of English sole with normal liver tissue compared to the occurrence of preneoplastic and neoplastic lesions are provided by station in Figure 3.



Lough. = Loughborough Inlet (Ref. site)
CH = Coal Hbr. CT = Centre Channel.
PM = Port Moody.

Preneoplasms = EF,BF,CCF
Neoplasms = LCA & HC

FIGURE 3 **PREVALENCES OF PRENEOPLASTIC AND NEOPLASTIC LESIONS FOUND IN ENGLISH SOLE FROM VANCOUVER HARBOUR AND THE REFERENCE SITE, LOUGHBOROUGH INLET - 1987**

The frequency of individual idiopathic liver lesions (including neoplasms, preneoplasms, and megalocytic hepatosis) in English sole are compared for Vancouver Harbour (1986 and 1987) and Eagle Harbour (Puget Sound, WA) in Table 2. The most frequently occurring lesions in the harbour in 1987 were basophilic foci (25.3%), eosinophilic foci (24.0%), and liver cell adenomas (14.7%). Corresponding Puget Sound values were reported as 26.5%, 30.5%, and 18.5%, respectively (Myers et al., 1987). The numbers and co-occurances of liver cell adenomas, eosinophilic foci, and basophilic foci were higher in Ioco compared to other stations (Appendix I).

TABLE 2 PERCENT FREQUENCY OF INDIVIDUAL PRENEOPLASTIC AND NEOPLASTIC LIVER LESIONS OCCURING IN ENGLISH SOLE FROM VANCOUVER HARBOUR (1986 AND 1987) AND EAGLE HARBOUR (PUGET SOUND) INCLUDING NEOPLASMA, PRENEOPLASMS, AND MEGALOCYTIC HEPATOSIS.

LESION	PERCENT AFFECTED		
	VANCOUVER HARBOUR 1987	1986[1]	EAGLE HARBOUR (PUGET SOUND)[2]
Neoplastic Lesions			
Liver Cell Adenoma	14.7	10.4	18.5
Hepatocellular Carcinoma	4.0	0	15.2
Preneoplastic Lesions			
Clear Cell Foci	4.0	7.5	8.0
Eosinophilic Foci	25.3	7.5	30.5
Basophilic Foci	24.0	10.4	26.5
Megalocytic Hepatosis	1.3	1.9	53.6

[1] Data taken from Goyette _et_ _al_. (1988)

[2] Data taken from Myers _et_ _al_. (1987)

The one considerable difference to Eagle Harbour data was the reduced number of English sole affected by megalocytic hepatosis. This condition was found in only 1.3% of the total number of English sole collected from Vancouver Harbour in current study and 1.9% in the previous year compared with the more than 50% of the fish sampled in Puget Sound (Table 2). Given that other idiopathic lesion frequencies are similar, the reason for this difference is unknown. In both Vancouver Harbour surveys, this degenerative lesion was found only in sole collected from the inner harbour which may suggest different xenobiotic chemicals within this area. Myers et al. (1987) had shown a potential association between megalocytic hepatosis and putatively preneoplastic foci of cellular alteration and suggests a potential utility for this lesion as an early indicator of hepatocarcinogen-hepatoxin exposure.

Although an increased sample size and modifications to histological procedures may have improved the original study design in 1987, the types of idiopathic liver lesions observed in Vancouver Harbour English sole for the two years of study showed similar trends. Consequently, the 1987 survey substantiated the results of the 1986 study. In attempting to relate the different idiopathic lesions observed in English sole, Myers et al. (1987) stated that the pattern of co-occurring lesion types was what would be expected in fish continuously exposed to various hepatocarcinogens and hepatotoxins in the sediments of Eagle Harbour. Similar investigations would be of interest in Vancouver Harbour.

PLATES

ENGLISH SOLE LIVER TISSUE MICROGRAPHS

PLATE 1	**NORMAL LIVER TISSUE** - A section of normal liver tissue showing hepatocytes (H), bile duct (BD), blood sinus (bs), pancreatic acini (PA), and melano-macrophage centers (m-mc). H&E. Bar = 500 μm.
PLATE 2	**ZOOPARASITIC INFECTION** - Infection of the bile ducts by the sporozoan Myxidium sp. (M). Normal hepatocytes (H) surround the infected bile duct. H&E. Bar = 500 μm.
PLATE 3	**ZOOPARASITIC INFECTION** - An external parasite (EP), most likely a nematode and normal hepatocytes (H) within the liver tissue. H&E. Bar = 100 μm.
PLATE 4	**ZOOPARASTIC INFECTION** - An inflammatory response manifested by the formation of a granuloma (G) due to an infection by an undetermined type of helminth. H = hepatocellular area of the liver. H&E. Bar = 500 μm.

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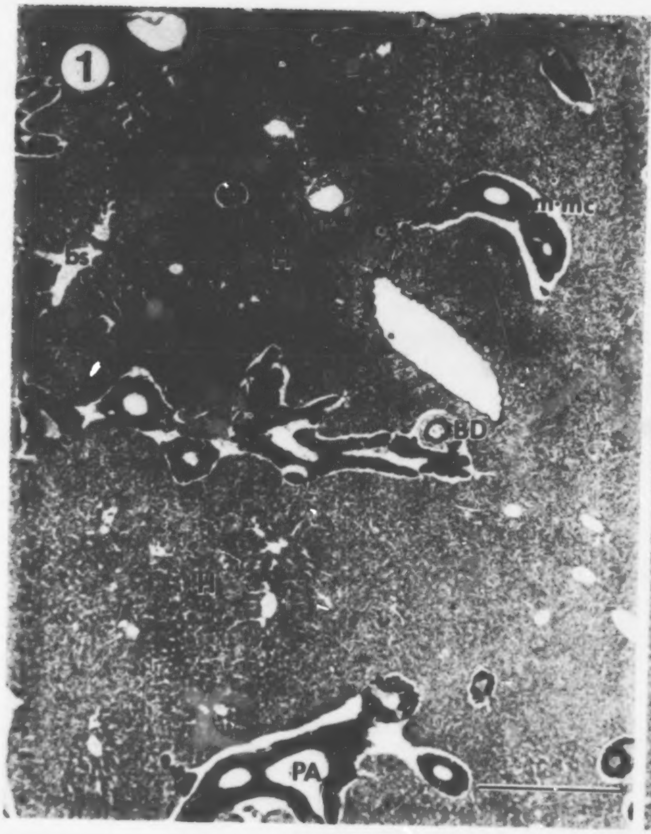
bs
mmc
BD
H
PA

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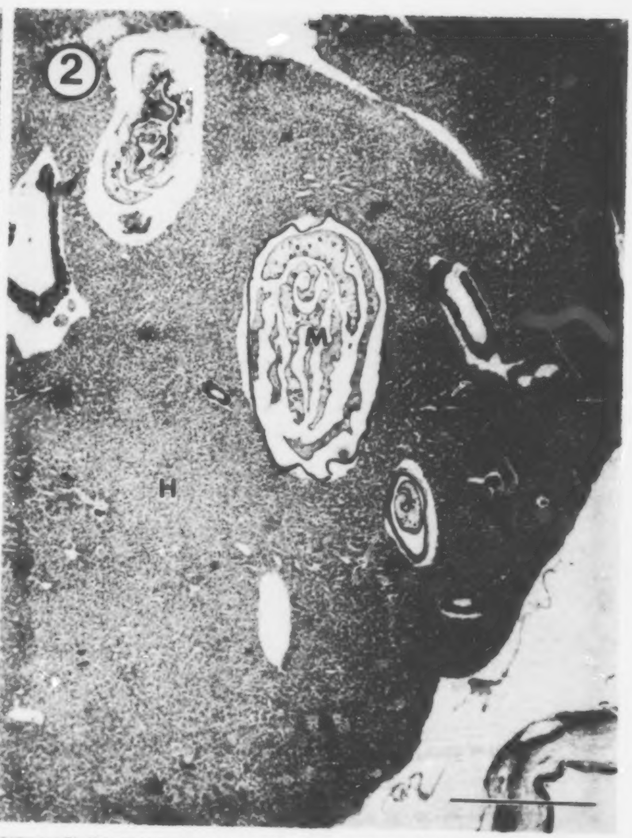

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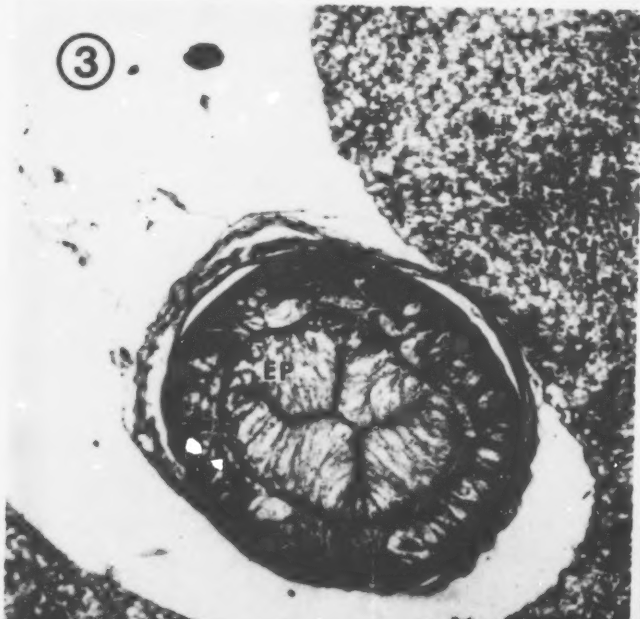

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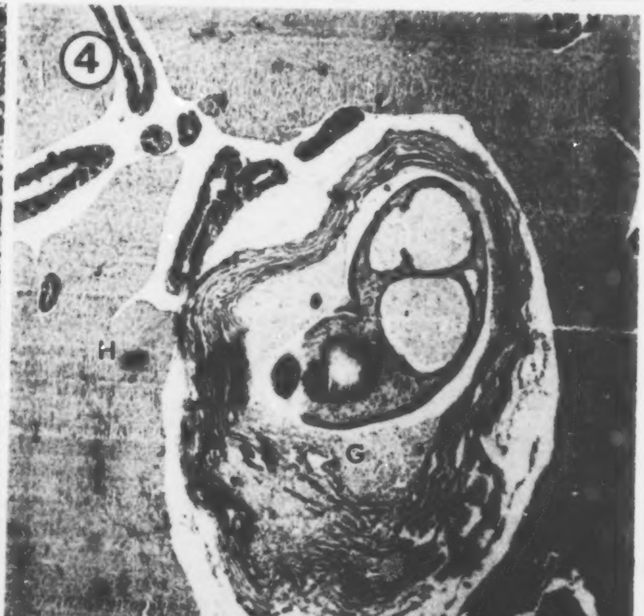
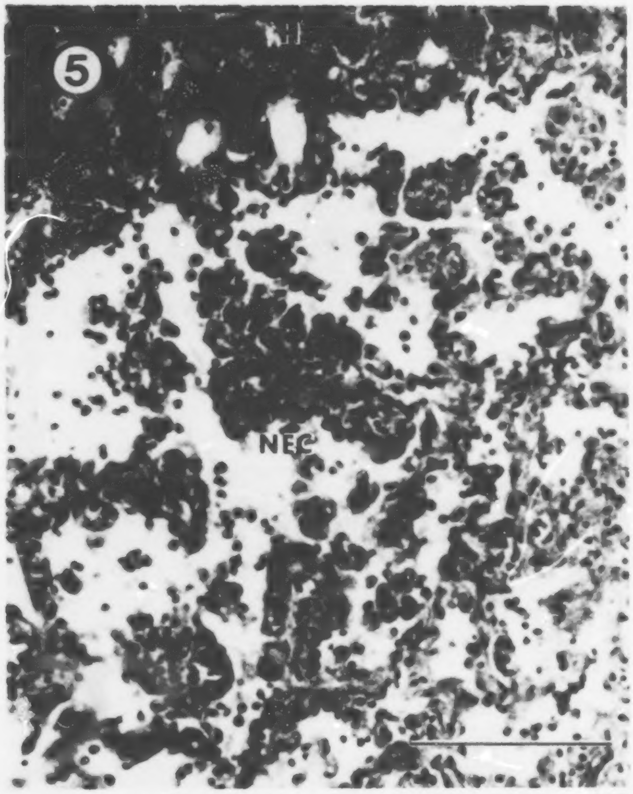


PLATE 5	**NONSPECIFIC NECROTIC LESION** of the hepatocytes (NEC) along with otherwise normal liver hepatocytes (H) located in the upper portion of this micrograph. H&E. Bar = 50 µm.
PLATE 6	**INTRACYTOPLASMIC STORAGE DISORDER** - Section of normal English sole liver with hepatocellular hemosiderosis (hh) seen as black granular material in this micrograph. PA = pancreatic acini and arrowheads point to melanomacrophage centers. Prussion blue. Bar = 100 µm.
PLATE 7	**INTRACYTOPLASMIC STORAGE DISORDER** - Section of liver tissue affected with hepatocellular hemosiderosis. Note the clear, spherical vacuoles within the hepatocytes. m-mc = melanomacrophage centers. H&E. Bar = 50 µm.
PLATE 8	**SPECIFIC DEGENERATIVE CONDITION** - Megalocytic hepatosis, showing enlarged hepatocytes with enlarged hyperchromatic nuclei. Arrowheads delineate area of normal sized nuclei within normal hepatocytes. PA = pancreatic acini. H&E. Bar = 50 µm.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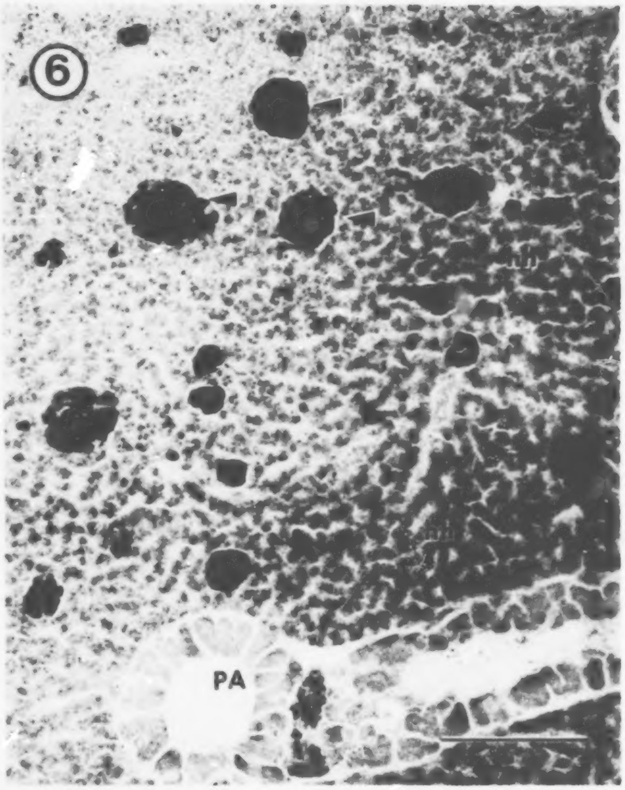
NEC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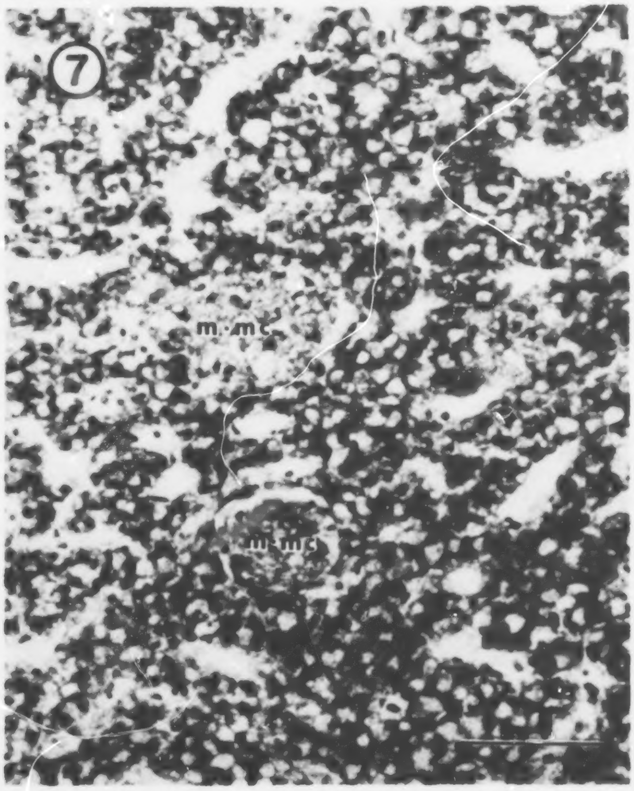
hh
hh
PA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m·mc
m·mc

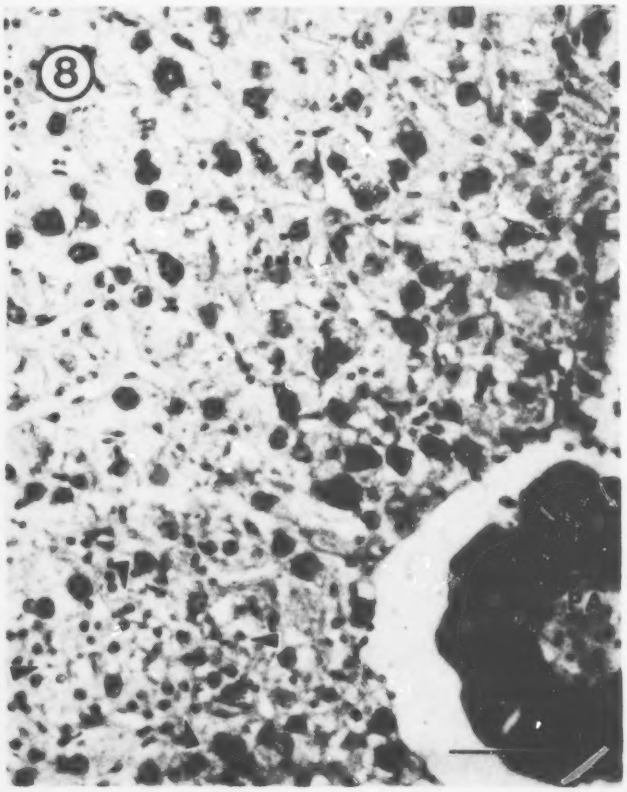
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PLATE 9	**FOCI OF CELLULAR ALTERATION** - Clear cell foci (CCF). H&E. Bar = 100 µm.
PLATE 10	**FOCI OF CELLULAR ALTERATION** - Eosinophilic foci (EF). H&E. Bar = 100 µm.
PLATE 11	**FOCI OF CELLULAR ALTERATION** - Basophilic foci (BF). H&E. Bar = 100 µm.
PLATE 12	**FOCI OF CELLULAR ALTERATION** - Basophilic foci (BF). H&E. Bar = 100 µm.

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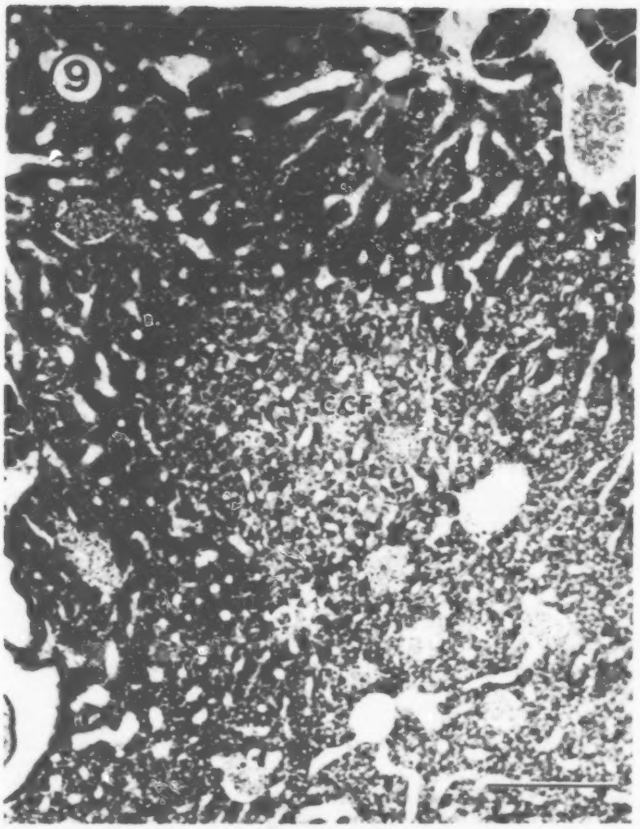

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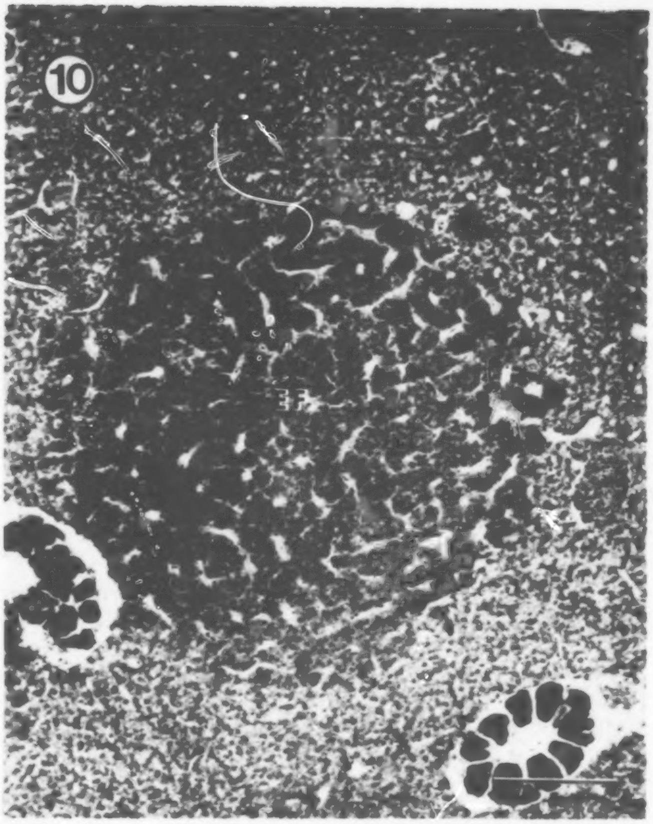

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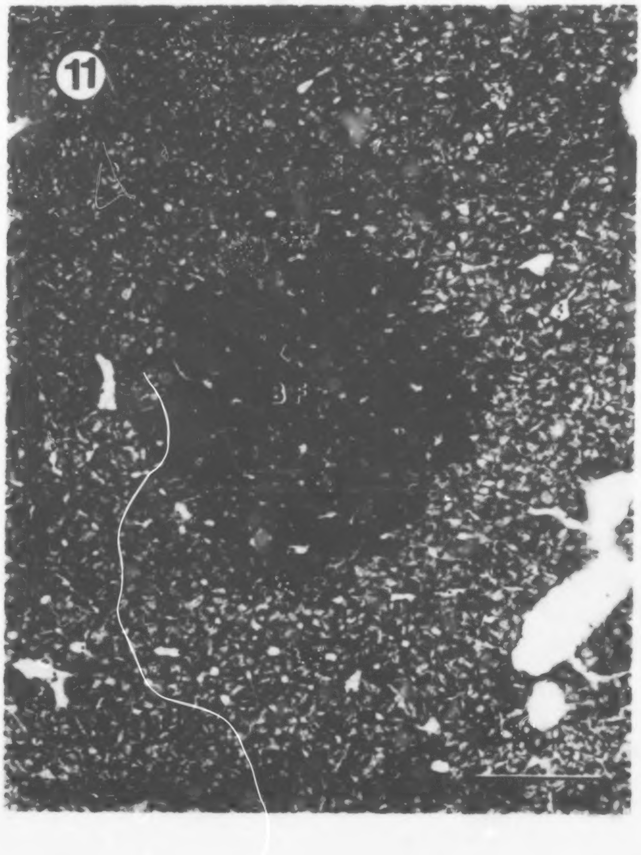

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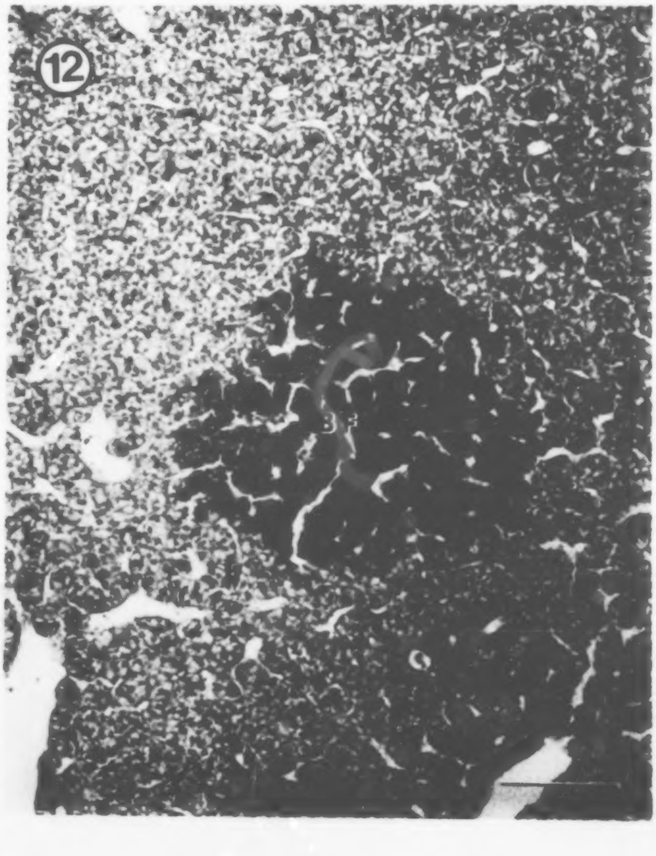
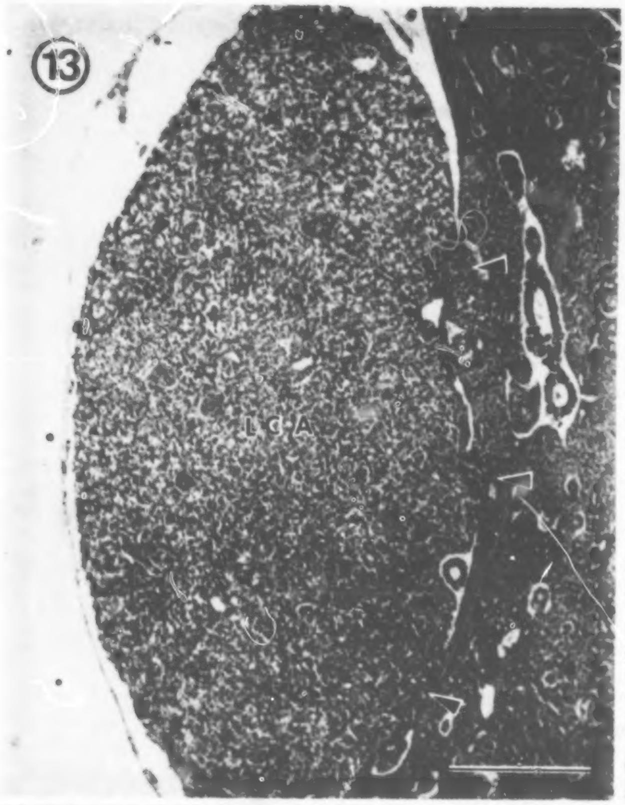
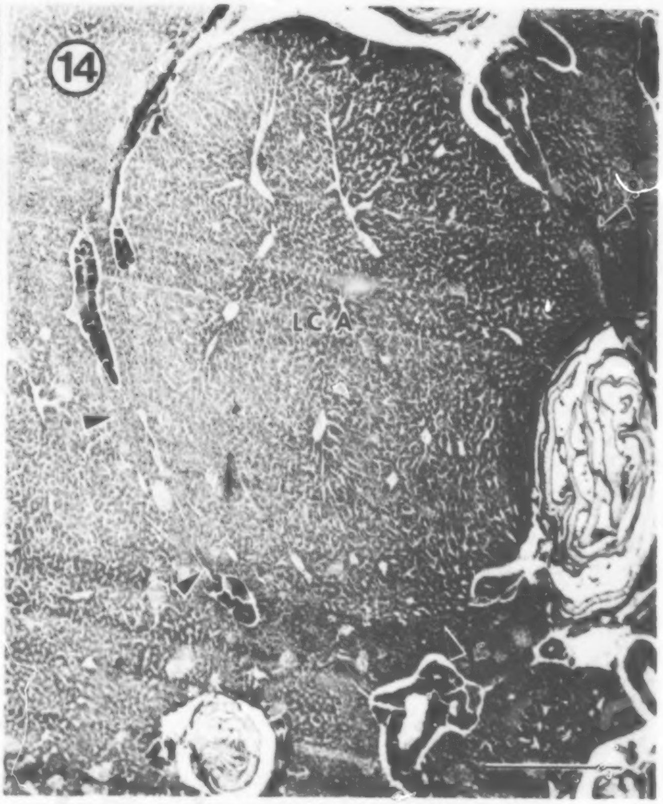


PLATE 13	**LIVER CELL ADENOMA** (LCA) - clear cell type. Arrowheads delineate borders of the adenoma. H&E. Bar = 500 µm.
PLATE 14	**LIVER CELL ADENOMA** (LCA) - eosinophilic type. Arrowheads delineate borders of the adenoma. H&E. Bar = 500 µm.
PLATE 15	**LIVER CELL ADENOMA** (LCA) - basophilic type. Arrowheads delineate borders of the adenoma. H&E. Bar = 500µm.
PLATE 16	**LIVER CELL ADENOMA** (LCA) - mixed type. Arrowheads delineate border of adenoma. H&E. Bar = 500µm.


⑬
LCA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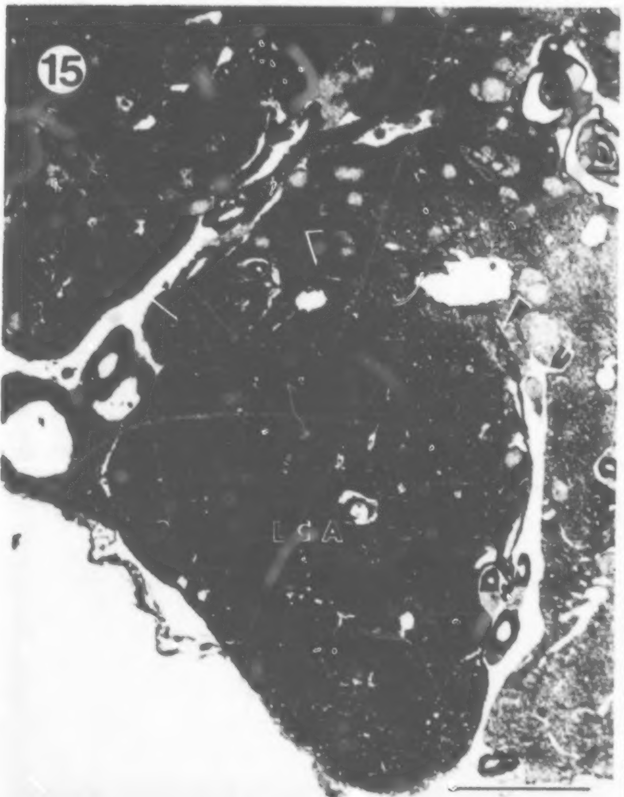
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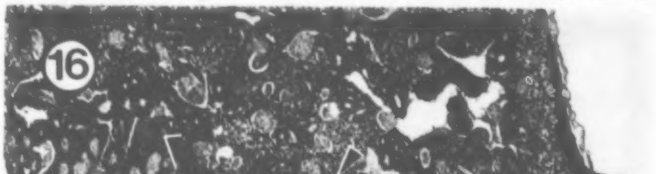
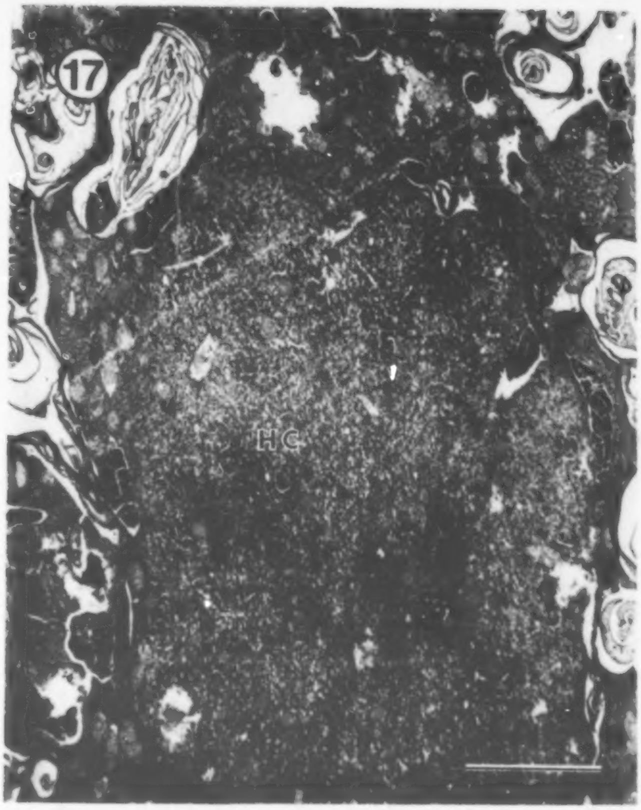

⑯
LCA

PLATE 17	**HEPATOCELLULAR CARCINOMA** (HC). H&E. Bar = 500 µm.
PLATE 18	**HEPATOCELLULAR CARCINOMA** - Higher magnification. H&E. Bar = 100 µm.
PLATE 19	**CHOLANGIOFIBROSIS** (CF). H&E. Bar = 500 µm.
PLATE 20	**CHOLANGIOFIBROSIS** - Higher magnification. H&E. Bar = 100 µm.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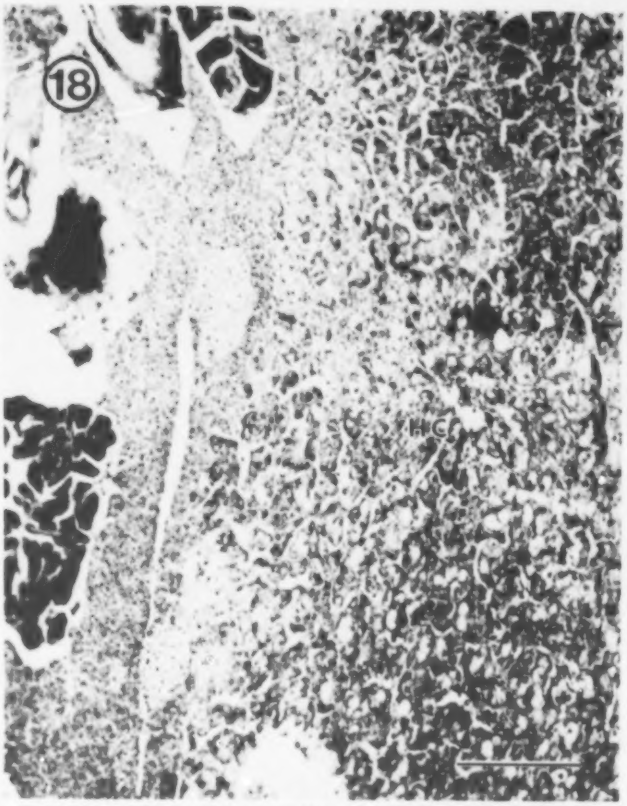
HC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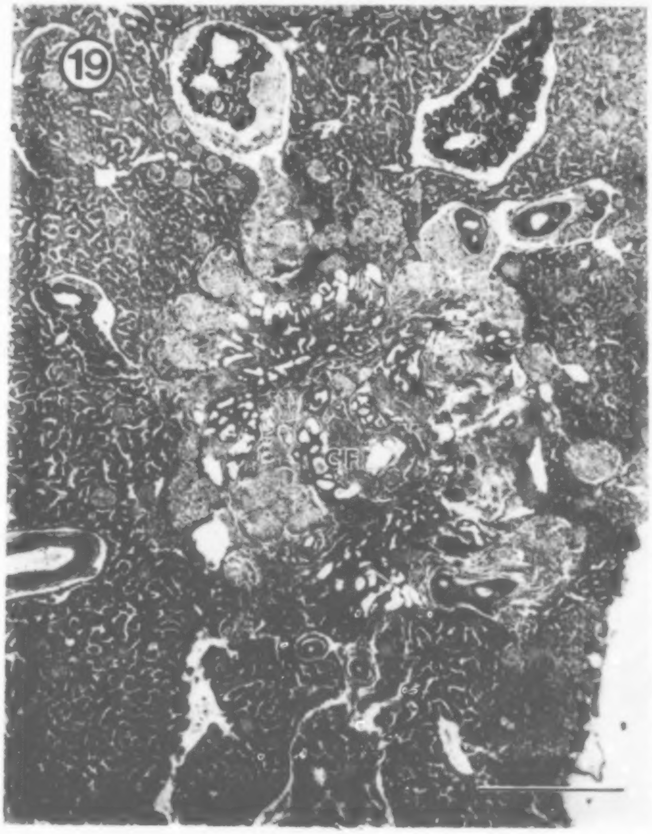
HC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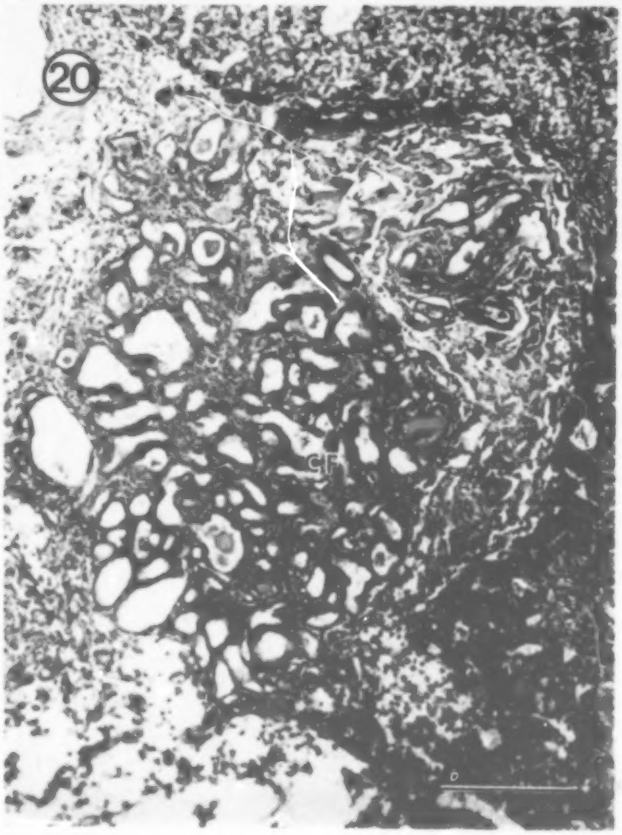
CF


⑳
CF

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APPENDIX I

GROSS MORPHOLOGY, HISTOPATHOLOGY AND PARASITIC RESULTS OF ENGLISH SOLE LIVER EXAMINATIONS

APPENDIX I GROSS MORPHOLOGY, HISTOPATHOLOGY, AND PARASITIC RESULTS OF ENGLISH SOLE LIVER EXAMINATIONS

Station: Loughborough Inlet (Reference Site)

LENGTH (cm)	GROSS MORPHOLOGY	HISTOPATHOLOGY	PARASITE
33	normal	normal	M
27	normal,EP	HH	M,EP,G
27	normal	NEC	M
29	normal	normal	M
20	normal,EP	normal	EP,G

LEGEND:

HH = hepatocellular hemosiderosis
NEC = nonspecific necrosis
EP = external parasite
G = granuloma
M = myxidium infection

APPENDIX I GROSS MORPHOLOGY, HISTOPATHOLOGY, AND PARASITIC RESULTS OF ENGLISH SOLE LIVER EXAMINATIONS (CONTINUED)

Station: Pacific Environment Institute (PEI)

LENGTH (cm)	GROSS MORPHOLOGY	HISTOPATHOLOGY	PARASITE
38	normal	normal	M
36	mottled	NEC,HH	M
36	normal	normal	M
38	mottled	NEC	M
41	normal	normal	M
36	normal	normal	-
35	normal	normal	M
33	normal	normal	M
32	normal	normal	M
31	white cyst	normal	M
31	normal	normal	M
33	normal	normal	M
34	lesion	NEC,BF	M,G
32	mottled	normal	M
31	normal	normal	M
31	normal	normal	M
30	normal	normal	M,EP
31	normal	normal	-
31	normal	normal	M,G
29	normal	normal	-

LEGEND:
NEC = nonspecific necrosis
HH = hepatocellular hemosiderosis
BF = basophilic foci
M = myxidium infection
G = granuloma
EP = external parasite

APPENDIX I GROSS MORPHOLOGY, HISTOPATHOLOGY, AND PARASITIC RESULTS OF ENGLISH SOLE LIVER EXAMINATIONS (CONTINUED)

Station: Ioco

LENGTH (cm)	GROSS MORPHOLOGY	HISTOPATHOLOGY	PARASITE
36	normal	NEC	M,G
31	normal	NEC,EF,BF	M
34	blood spot	NEC,EF,BF,CF	O
32	normal	EF,BF	M
31	lesions	BF	M,G
35	lesions	CF	M
32	lesions	CCF,EF,BF,LCA,HC	M
33	normal	NEC,EF,BF	M
35	lesions	NEC,EF,CF	M,G
36	lesions	NEC	M
39	lesions	BF,LCA,HC	M,G
32	lesions	NEC,HS,EF,BF,LCA	M,G
32	lesions	HS,EF,CF	M
33	lesions	CCF,EF,BF,LCA,HC	M
31	lesions	HH	M
33	lesions	HH,EF,BF	M

LEGEND: NEC = nonspecific necrosis
EF = eosinophilic foci
BF = basophilic foci
CF = cholangiofibrosis
CCF = clear cell foci
LCA = liver cell adenoma
HC = hepatocellular carcinoma
HS = hepatocellular steatosis
HH = hepatocellular hemosiderosis
M = myxidium infection
G = granuloma
O = oocyte-like body.

APPENDIX I GROSS MORPHOLOGY, HISTOPATHOLOGY, AND PARASITIC RESULTS OF ENGLISH SOLE LIVER EXAMINATIONS (CONTINUED)

Station: Port Moody

LENGTH (cm)	GROSS MORPHOLOGY	HISTOPATHOLOGY	PARASITE
30	EP,mottled	NEC,BF	M,EP
29	mottled, lesion	EF,BF,LCA	M
32	mottled, lesion	EF,BF,LCA	-
33	mottled, lesion	HH	M,G
38	mottled, lesion	HH	M,EP,G
31	mottled, lesion	NEC	-
30	EP	normal	EP
31	lesion	normal	G
34	white cyst	normal	M,G
34	lesion	HH	-
32	normal	normal	M
33	EP	normal	-
32	lesion	EF,BF,LCA	M
32	EP	CCF,EF,BF,LCA	EP
30	white cyst	EF,BF,LCA	M,G
30	mottled	normal	-
29	normal	normal	G
28	EP	normal	EP,G
28	mottled	NEC,EF	-
28	mottled	normal	M,EP

LEGEND: EP = external parasite
NEC = nonspecifice necrosis
BF = basophilic foci
EF = eosinophilic foci
LCA = liver cell adenoma
HH = hepatocellular hemosiderosis
CCF = clear cell foci
M = myxidium infection
G = granuloma

APPENDIX I GROSS MORPHOLOGY, HISTOPATHOLOGY, AND PARASITIC RESULTS OF ENGLISH SOLE LIVER EXAMINATIONS

Station: Centre

LENGTH (cm)	GROSS MORPHOLOGY	HISTOPATHOLOGY	PARASITE
29	normal	normal	-
30	normal	normal	M
28	normal	normal	-
28	mottled	normal	M,G
26	mottled	normal	-
26	lesion	normal	M,EP,G
25	white cyst	NEC,EF,BF,LCA	M,EP
25	white cyst	normal	M,G
25	normal	EF	-
24	mottled	EF	M,EP,G
32	lesion	LCA	G
28	normal	normal	M
29	mottled	normal	M
26	normal	normal	G
25	normal	MH,REG	M
25	EP	normal	M,EP
25	mottled	NEC,BF	M,G
25	normal	NEC	M
26	EP	HH	EP

LEGEND:
EP = external parasite
NEC = nonspecific necrosis
EF = eosinophilic foci
BF = basophilic foci
LCA = liver cell adenoma
MH = megalocytic hepatosis
REG = hepatocellular regeneration
HH = hepatocellular hemosiderosis
M = myxidium infection
G= granuloma